
# Physical activity patterns in children and adolescents, and the contribution of physical education classes to daily physical activity, according to gender and body mass index.

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*“Aqueles que passam por nós não vão sós, não nos deixam sós.*
*Deixam um pouco de si, levam um pouco de nós.”*
*Antoine de Saint – Exupéry*

*A todos aqueles que se cruzaram comigo*
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# ABSTRACT

The priorities of international recommendations in school-aged children and adolescents call for the increase of moderate to vigorous activities (MVPA) and physical fitness for health benefits, advocating 60 minutes of daily MVPA. However, evidence has suggested that the majority of children and adolescents do not achieve the 60 minutes per day of these activities. School-based Physical education (PE) is the most widely available source to promote physical activities among young people and for many youngsters PE provides the most relevant opportunity to be engaged in PA. Although the evidences suggested low levels of PA in PE few studies have focused their investigation on the contribution of PA performed during PE to daily PA. Therefore, the aims of this thesis were: a) evaluate PA levels during PE classes with different durations; b) analyze MVPA performed and compliance with international guidelines for children and adolescents; c) investigate the association of PA levels on PE classes with gender and weight status; d) examine the contribution that PE classes gives to daily PA levels, comparing physical activity realized in days with physical education classes, days without physical education classes and weekends. This study was conducted in four Portuguese public schools with volunteers aged between 10 to 18 years. PA was assessed using an Actigraph accelerometer during 7 consecutive days. Data were analyzed with specific software and using age-specific counts-per-minute cut-off points. We observed students' behavior in the two PE classes that they have during the week, for a total of 119 PE classes. Cross-sectional results from our thesis suggest that there was no difference in the PA realized in PE classes with different durations (45PE and 90PE), except for Sedentary Behavior (SB) which is higher in 90PE than in 45PE. The proportion of MVPA is lower than the 50% recommended. Furthermore, boys spent significantly more time engaged in MVPA and girls spent more time in SB and Light Physical Activity (LPA) and NOW spent significantly more time engaged in MVPA than OW. OW were approximately three times more likely not to meet the > 50% MVPA in 45PE classes than their NOW counterparts. Days with 45 minutes' physical education classes (PED45) contribute, on average, 16.9% for the daily MVPA and days with 90 minutes' physical education classes (PED90) accounted for 32.2%. All students engaged in more MVPA on PED than NPED or WD ($P<0.05$). PE classes were associated with higher odds to accomplish the recommended 60 min of daily MVPA. In conclusion, findings from our research suggest that PE increased the daily MVPA levels and played a considerable role in providing PA to accomplish PA guidelines.



**KEYWORDS:** Accelerometry; Physical Activity; Physical Education; Recomendations; Children and Adolescents.

# RESUMO

As prioridades das recomendações internacionais em crianças e adolescentes, em idade escolar, sugerem o aumento das atividades físicas moderadas a vigorosas (MVPA) e da aptidão física para que haja benefícios para a saúde, defendendo a prática diária de 60 minutos de atividades físicas moderadas a vigorosas. No entanto, as evidências sugerem que a maioria das crianças e adolescentes não atingem os 60 minutos por dia, dessas atividades. A Educação Física escolar (PE) é a fonte mais amplamente disponível para promover a PA entre os jovens. Para muitos jovens, as aulas de PE oferecem a oportunidade mais relevante de se envolverem em PA. Embora as evidências sugiram baixos níveis de PA nas aulas de PE, poucos estudos focaram a sua investigação na contribuição da PA realizada durante as aulas de PE para a PA diária. Nesse sentido, com a realização desta tese pretendemos: a) avaliar os níveis de PA durante as aulas de PE com diferentes durações; b) analisar as MVPA realizadas e o cumprimento das diretrizes internacionais para crianças e adolescentes; c) investigar a associação dos níveis de PA nas aulas de PE em função do sexo e do peso; d) examinar a contribuição das aulas de PE para os níveis diários de PA, comparando a PA realizada em dias com aulas de PE, dias sem aulas de PE e fins de semana. Este estudo foi realizado em quatro escolas públicas portuguesas com voluntários entre os 10 e os 18 anos. A PA foi avaliada usando um acelerómetro Actigraph durante 7 dias consecutivos. Os dados foram analisados com software específico e usando os pontos de corte de contagens por minuto específicos para a idade. Observamos o comportamento dos alunos nas duas aulas de PE semanais, para um total de 119 aulas de PE analisadas. Os resultados transversais da nossa tese sugerem que não houve diferença na PA realizada em aulas de PE com diferentes durações (45PE e 90PE), exceto para o comportamento sedentário (SB), que é maior nas aulas 90 minutos do que nas de 30. A proporção de MVPA é inferior aos 50% recomendados. Adicionalmente, os rapazes gastaram significativamente mais tempo em MVPA e as raparigas em SB e Atividade Física Ligeira (LPA). Os NOW passaram significativamente mais tempo em MVPA do que os OW. Os OW são aproximadamente três vezes mais propensos a não cumprir os 50% da aula de 45 minutos em MVPA do que os seus homólogos NOW. Dias com aulas de educação física de 45 minutos (PED45) contribuíram, em média, 16,9% para o MVPA diário e os dias com aulas de educação física de 90 minutos (PED90) representaram 32,2%. Todos os alunos participaram em mais MVPA em PED do que NPED ou WD ($P < 0,05$). As aulas de PE foram associadas a maiores probabilidades de realizar os 60 minutos recomendados de MVPA diário. Em conclusão, os nossos resultados sugerem que a PE aumentou os níveis diários de MVPA e desempenhou um papel considerável no fornecimento de PA para o cumprimento das diretrizes de PA.



**PALAVRAS-CHAVE:** ACELEROMETRIA; ATIVIDADE FÍSICA; EDUCAÇÃO FÍSICA; RECOMENDAÇÕES; CRIANÇAS E ADOLESCENTES.

## List of Abbreviations

| | |
|---|---|
| BMI | Body Mass Index |
| CRF | Cardiorespiratory Fitness |
| CVD | Cardiovascular Disease |
| LPA | Light Physical Activity |
| MPA | Moderate Physical Activity |
| MVPA | Moderate to Vigorous Physical Activity |
| NPED | Days Without Physical Education Classes |
| NOW | Non-Obese Group |
| OW | Overweight and Obese |
| PA | Physical Activity |
| PE | Physical Education Classes |
| PED | Days with Physical Education Classes |
| SB | Sedentary Behavior |
| TPA | Total Physical Activity |
| VPA | Vigorous Physical Activity |
| WD | Weekends |
| WHO | World Health Organization |
| OW | Overweight and Obesity |
| 45PE | 45 minutes Physical Education Classes |
| 45PED | Days with 45 minutes Physical Education Classes |

| | |
|---|---|
| 90PE | 90 minutes Physical Education Classes |
| 90PED | Days with 90 minutes Physical Education classes |

# GENERAL INTRODUCTION

The recognition of cardiovascular disease as a pediatric problem has been growing in the last years. Advanced atherosclerotic injuries, a subclinical state of some forms of cardiovascular disease, like the coronary heart diseases, were already reported in children and youth (L. B. Andersen et al., 2006). Also, cardiovascular risk factors like hypertension, higher levels of cholesterol, obesity, sedentary life style, and lower levels of cardiorespiratory fitness (CRF) and physical activity (PA) were stated in children and adolescents (L. B. Andersen et al., 2008; D. P. Bailey, Boddy, Savory, Denton, & Kerr, 2012). Most unpleasant, obesity and clustered cardiovascular risk factors start occurring in youth and track trough years (Ekelund et al., 2007; Ortega, Ruiz, & Castillo, 2013) as well as low fitness and sedentary behaviors (L. Aires, Andersen, et al., 2010). The need to develop and implement strategies for primary prevention of obesity and cardiovascular disease in early ages is an established consensus (Lars Bo Andersen, Hasselstrøm, Grønfeldt, Hansen, & Karsten, 2004; D. P. Bailey et al., 2012). Assuming that adequate levels of PA and healthy diets could influence CRF, body fatness and, by consequence, the metabolic profile, it seems rational to intervene over sedentary behaviors and unhealthy habits to improve cardiovascular health since youth (Janssen & Leblanc, 2010). Some studies have reported that the clustering is associated with low levels of PA and some effect modification by obesity and CRF (Eisenmann, Welk, Ihmels, & Dollman, 2007; Ekelund et al., 2007). Conversely, increased levels of physical activity and high CRF levels seems to be inversely associated to the prevalence and clustering of cardiovascular disease risk factors (L. Aires, Andersen, et al., 2010; L. B. Andersen et al., 2006). In youths, there is enough evidence pointing that subjects whom gather larger amounts of moderate to vigorous physical activity (MVPA) demonstrate lower levels of body fatness and clustered metabolic risk (L. Aires, Mendonça, et al., 2010; D. P. Bailey et al., 2012).

Current guidelines for PA have suggested that children and adolescents should accumulate at least 60 minutes of MVPA daily (World Health Organization, 2010). These guidelines are recommended in order to improve body composition, cardiorespiratory and muscular fitness, bone health, cardiovascular and metabolic health biomarkers and reduce symptoms of anxiety and depression

(Strong et al., 2005; World Health Organization, 2010). However, it seems that just around 20% to 40% of children and adolescents, depending on gender and overweight status, are able to meet the 60min/day of MVPA guideline (D. Martinez-Gomez et al., 2010). Because sedentary behaviors tracks over time (Cooper et al., 2015; Mitchell, Pate, Beets, & Nader, 2013), it seems relevant to intervene since the early ages. School is the privilege set to intervene because it can involve and influence a large number of children with low cost and with family proximity (Cale & Harris, 2013). Schools can provide many opportunities for young people to engage in PA and can play an important role in motivating young people to stay active (Expert Group on Health-enhancing physical activity, 2015; Kretschmann, 2014; Sallis et al., 2012b).

Physical education classes (PE) represent a set where adolescents can engage in PA of sufficient quantity and quality to promote health-related benefits (Meyer et al., 2013), providing children with opportunities to be physically active and teaching them the knowledge and movement skills that lead to active lifestyles (S. J. Fairclough & G. Stratton, 2005). Since most youth attend school, the role of PE in the development of PA behavior, and subsequent physical fitness, has become a central principle in reducing sedentary behavior (Bevans, Fitzpatrick, Sanchez, Riley, & Forrest, 2010; Kretschmann, 2014; Sanchez-Vaznaugh, Sánchez, Rosas, Baek, & Egerter, 2012). However, PE faces numerous challenges including pervasive inactivity among children and families (Nader, Bradley, Houts, McRitchie, & O'Brien, 2008), competing with academic priorities (Pate & O'Neill, 2008) and budget limitations (Thomas L. McKenzie & David Kahan, 2008) .

Daily PE is recommended for public health purposes, but mandates for PE differ by country. For instance, a USA national survey indicate that 55.7% of high school students were enrolled in PE classes, 28.4% attended PE class daily, and 80.3% of those attending PE classes spent 20 minutes being active during that class (Russell R. Pate et al., 2006). In the Portuguese educational system, curricula undertake some fundamental conditions: PE is mandatory for all students from 5th to 12º grade; PE class was enlarged from 135 to 180 minutes per week for adolescents group; teachers are specialized and, optionally,

students can participate in school sportive clubs during extra curriculum schedule. However, classes are still too large, playgrounds too small, which hinder the task of rising motor density, frequency and mean length of classes (Bevans et al., 2010; Smith, Monnat, & Lounsbery, 2015).

Some studies have explored the amount of PA of different intensities expended during PE classes and its determinants. Reviews on this field (Stuart J. Fairclough & Gareth. Stratton, 2006) (Stuart J. Fairclough & Gareth. Stratton, 2006) have summarized a variety of studies and demonstrated that results and conclusions are diverse, probably given to differences throughout methodologies, especially in the collection of PA data. The mean percentage of class time devoted to MVPA ranged from 33.8±13.6% to 49.9±19.8%, despite methodological differences (S. J. Fairclough & G. Stratton, 2005; Stuart J. Fairclough & Gareth. Stratton, 2006; Meyer et al., 2013). In the most of the studies, the methods of PA assessment vary from systematic observation through heart rate monitors, pedometry and accelerometry (S. J. Fairclough & G. Stratton, 2005; Stuart J. Fairclough & Gareth. Stratton, 2006). Nevertheless, some research has been made to identify which variables could be considered the determinants of PA levels during PE classes (S. J. Fairclough & G. Stratton, 2005). In this field, some studies have explored age and gender differences (Ferreira, Mota, & Duarte, 2014; Viciana, Martínez-Baena, & Mayorga-Vega, 2015b), while others have explored teaching behaviors, lessons contexts (Hino, Reis, & Rodriguez-Añez, 2007; McKenzie, Marshall, Sallis, & Conway, 2000), curricular and organizational strategies (Smith et al., 2015), facilities (Cohen, Scott, Frank Zhen, McKenzie, & Porter, 2008), human and material resources (Bevans et al., 2010). However, the associations of physical education school-based physical activity to obesity and health-related fitness are not yet clear (Beets & Pitetti, 2005; Ekelund et al., 2012).

Previous, effective school-based interventions have included additional PA sessions or modified PE classes to increase moderate to vigorous PA. However, particularly in Portugal, curriculum and school schedule adaptations are difficult. Thus, it would be necessary to implement health promotion interventions trough the Health Education Program (HEP), restructuring the curriculum of the PE

Lessons. The HEP consists in a series of curricular activities for health promotion suggested and encouraged by the World Health Organization and by the European Commission and the Council of Europe, by the Schools for Health in Europe (SHE) Network. However, it is crucial to describe the PA levels during PE classes, compare classes with different durations and analyze the contribution that PE gives to TPA (Total Physical Activity) and daily MVPA, examining days with PE classes (PED), days without PE classes (NPED) and weekends (WD). Furthermore, it is crucial to investigate those associations with gender and obesity. Just with this knowledge it would be possible to sustain and justify future educational policies and curricular adaptations.

Therefore, the aims of this thesis and the original articles on which this thesis is based are the following:

1. Evaluate PA levels during PE lessons with different duration, analyzing the MVPA performed and their compliance with international guidelines for children and adolescents.
    I. Physical Activity levels, Patterns of Moderate to Vigorous Physical Activities in Physical Education Classes and compliance with guidelines for Youth.
    II. Relationship of objective measurement Physical Activity levels in Physical Education classes and Body Mass Index in Youth.
2. Analyze the contribution of PE classes for the daily compliance with the recommendations for physical activity, comparing physical activity realized in days with physical education classes, days without physical education classes and weekends.
    III. Contribution of Physical Education Class for the Daily Physical Activity.

# CHAPTER I – THEORETICAL BACKGROUD

## 1. Physical Activity and Health

Recent studies published by the World Health Organization (WHO)(World Health Organization, 2014), call attention to the worrying situation of the current world health.

Sedentary behaviors (SB) are identified as one of the four major risk factors responsible for global mortality (6% of deaths worldwide) only surpassed by hypertension (13%), tobacco use (9%) and elevated glucose (6%). Physical inactivity causes 6–10% of cases of coronary heart disease, diabetes and breast and colon cancer and 9% of premature mortality. Overweight and obesity (OW) contribute to 5% of deaths worldwide. As a result, the growing prevalence of noncommunicable diseases and their risk factors are currently a worldwide problem, affecting 45% of adults in countries with underdeveloped and developing economies (World Health Organization, 2014).

It is globally accepted the premise that healthy lifestyles should include practice of regular PA (Ekelund et al., 2012; Lee & Paffenbarger, 2009). Studies report that regular participation in PA reduces the risk of heart disease and stroke, diabetes, hypertension, colon cancer, breast cancer and depression (United States Department of Health and Human Services, 2000). PA also plays a key role in energy expenditure allowing the regular energy balance and weight control (World Health Organization, 2014). Studies developed around this issue revealed that higher energy expenditure is associated with increased longevity and greater participation in moderate activities showed a trend of low mortality, while better energy expenditure in vigorous activities clearly predicted the lower mortality rates (Lee & Paffenbarger, 2009). In youngsters, there is enough evidence pointing out that those whom gather larger amounts of MVPA demonstrate lower levels of body fatness and clustered metabolic risk (Lars Bo Andersen et al., 2006; Ekelund et al., 2012).

There are convincing evidences of atherosclerosis, and their precursors, appear at an earlier age, during infancy, progressing for adulthood, often leading to cardiovascular diseases, the largest cause of death in most industrialized countries (Dietz, 2004; Telama et al., 2005). For the other hand, attitudes related

to the practice of PA, are largely ingrained in childhood and adolescence and studies suggest that they tend to prolong by adulthood (Menschik, Ahmed, Alexander, & Blum, 2008; Telama et al., 2005).

Young's physical inactivity has been categorized as a modifiable risk factor for lifestyle-related diseases(Hussey, Bell, Bennett, O'Dwyer, & Gormley, 2007; Strong et al., 2005) Moreover, it has been suggested that adequate participation in regular PA during childhood might be of critical importance for the prevention of chronic diseases in adulthood (World Health Organization, 2014). Thus, there are excellent reasons for promoting a healthy lifestyle in early ages. The society must be more preventive instead trying to counter the irreversible pathological changes already established.

## 1.1 Physical Activity Definition

Having conscience of the vital relevance of the practice of PA on the health of young people, first of all, it is essential to define the concept of PA.

PA concept has undergone changes over the time, since it is an extremely complex behavior (Caspersen, Powell, & Christenson, 1985; Puyau, Adolph, Vohra, & Butte, 2002). PA is defined as any bodily movement produced by skeletal muscles that require energy expenditure and it includes occupational work, chores, leisure activity, playing sports, and exercise that is planned for fitness or health purposes (Caspersen et al., 1985). PA includes sports as well as non-sports activities. Sports and exercise are connected, sports are often planned, structured, and repetitive, with the objective of improving or maintaining physical fitness, whereas non-sports activities can be subdivided into different categories such as occupational, household activities, transportation activities, personal care and leisure-time (including recreational activities, competitive sports and exercise/exercise training) (Caspersen et al., 1985). Exercise is a subset of PA that involves purposive structure, and repetitive movements with the aim of improving or maintaining one or more components of physical fitness (i.e., cardio-respiratory and muscular fitness). It is carried out in a more structured

manner, often performed at a greater intensity (more vigorous) (Dishman, Motl, et al., 2004; World Health Organization, 1995).

PA is a multi-dimensional concept that suffers and exercises influence on numerous factors, such as physical fitness, health and consequently, well-being, morbidity and mortality (Bouchard, Shephard, & Stephens, 1994). Different types and amounts of PA are required for different health outcomes (Dishman, Heath, & Washburn, 2004).

Experts recommend all children and youth should be physically active daily as part of play, games, sports, work, transportation, recreation, physical education, or planned exercise in the context of family, school, and community activities (Mark S. Tremblay et al., 2011).

## 1.2 Dimension of Physical Activity

Measuring PA could be difficult since no single method can capture all domains of PA observed. In general, PA is commonly described as having the following 4 main dimensions (Chris J, 2004; Dishman, Heath, et al., 2004):

- Duration: refers to a time of participation in a single bout of PA (Caspersen et al., 1985).
- Intensity: mentions to a physiological effect associated with participating in a special type of PA(Caspersen et al., 1985). Generally, energy expenditure (EE) is commonly used to determine PA intensity, while quantitative information on total daily EE expressed as units of EE (i.e., kcal or kj). According to health benefits, higher-intensity activities require less time spent participating in that activity, whereas lower-intensity activities require more time spent participating in the activity (see Figure 1).
- Frequency: is the number of events of PA during a specific time period (Caspersen et al., 1985).
- The type or mode: mentions to the form of the activity, its rate or pace, and its continuity (Dishman, Heath, et al., 2004).

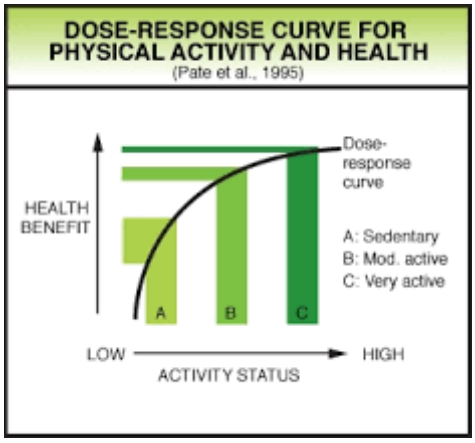


**Figure 1. The benefits of changing sedentary people to exercising people have the greatest potential for public health benefit.**

(Adapted from Pate, R. R., Pratt, M., Blair, S. N., Haskell, W. L., Macera, C. A., Bouchard, C., et al. (1995). Physical activity and public health. A recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine. JAMA, 273(5), 402-407.)

(Pate et al., 1995)

## 2. Young Physical Activity And Health

Due to the profound changes in lifestyle of the population, PA of children and adults has been decreasing gradually, being worrying the current trend to physical inactivity that starts to settle in our society. It is widely accepted that regular PA is a very important behavior to promote a healthy lifestyle, both in childhood and youth as in adulthood.

Adolescence is defined as the period of human development between 10 and 19 years of age (World Health Organization, 2015) and studies suggest that it is a critical life period to perform PA. It is common to see a decrease on PA levels with age (Dumith, Hallal, Reis, & Kohl, 2011; Ortega et al., 2013) and previous studies have shown the decline of PA from childhood to adolescence (Nader et al., 2008; Trost, Owen, Bauman, Sallis, & Brown, 2002), even as from adolescence to adulthood (Telama et al., 2005). This decrease on PA levels occurs in both genders (Nader et al., 2008; Ortega et al., 2013; Trost et al., 2002), but evidence confirms that boys are more likely to be active than girls in all age groups (Baptista et al., 2012; Nader et al., 2008; Trost et al., 2002)), and social and cultural contexts could affect the gender differences in PA involvement (Yang

et al., 2007). Youngsters PA behaviors vary in bout in frequency, duration, and intensity depending on the setting where they occur. S. J. Fairclough, Ridgers, and Welk (2012) suggest there is greater uniformity in school day activity compared to after-school and WD, which allow more behavioral choice and different patterns of PA levels are observed during the week versus WD (Laguna et al., 2013). Within such contexts, SB and PA levels can vary markedly due to the influence of multidimensional correlates (Stanley, Ridley, & Dollman, 2012). Weekends present more discretionary time for SB and PA, but also lack the regular routines and structures of school weekdays which determine a significant proportion of children's daily SB and PA(S. J. Fairclough et al., 2012). In addition, previous research found weekend PA to be lower than on WD (S. J. Fairclough, Boddy, Mackintosh, Valencia-Peris, & Ramirez-Rico, 2015).

During childhood and adolescence, assuring an adequate PA habit is an important issue because young people can see it enhance their physical, psychological, and social well-being (Best, 2010; Hallal, Victora, Azevedo, & Wells, 2006). Longitudinal research has established that adolescents who are more physically active become more physically active adults (Telama et al., 2005). Moreover, high PA levels have been associated with a reduced risk of OW (Ortega et al., 2013)and higher levels of CRF(Ortega et al., 2013). In a study conducted in a Portuguese sample, Martins et al. (2010) have shown that CRF was positively associated with a lower prevalence of CVD.

Additionally, it has also been suggested that physically active young people more readily adopt other healthy behaviors (e.g., avoidance of tobacco, alcohol and drug use) and demonstrate higher academic performance at school (Forbes, 2003; World Health Organization, 2015). It is currently discussed that at the same time that the increase of PA seems to be essential to have health benefits, it is critical to reduce SB, which has grown up in large scale on adolescence (Mitchell et al., 2013).

High prevalence of SB is a strong contributor to OW and is also related to several diseases including high blood pressure, metabolic syndrome and increased cardiovascular risk (Hu, 2003; Marshall, Biddle, Gorely, Cameron, & Murdey, 2004). Our young generation spends even more time in sedentary

activities such as screen-time activities and telephone conversations (Adilson Marques, Calmeiro, Loureiro, Frasquilho, & Matos, 2015; Pate, Mitchell, Byun, & Dowda, 2011) and during weekdays these behaviors are highly significant (Sallis, 2000). Therefore, the promotion of youngsters' PA and reducing SB is an important public health priority (World Health Organization, 2014).

## 2.1 Young Physical Activity Recommendations

In the last decade much effort has been put into the understanding of the biological mechanisms by which PA provides benefits for health and the PA profile, type, intensity and amount, that it is associated with enhanced health and quality of life in order to develop PA guidelines for young (Carson et al., 2016; D. Martinez-Gomez et al., 2010; Strong et al., 2005), suggesting the minimum levels of PA required for positive health benefits.

World Health Organization (2010), suggest that for children and young people, PA may include play, games, sports, transportation, chores, recreation, physical education, or planned exercise, in the context of family, school, and community activities. In order to improve cardiorespiratory and muscular fitness, bone health, and cardiovascular and metabolic health biomarkers youngsters should accumulate at least 60 minutes of moderate to vigorous PA daily. Amounts of physical activity greater than 60 minutes provide additional health benefits and most of the daily physical activity should be aerobic. Vigorous-intensity activities should be incorporated, including those that strengthen muscle and bone, at least 3 times per week.

These recommendations are relevant to all healthy children and adolescent unless specific medical conditions indicate to the contrary and are applicable for all children and youth irrespective of gender, race, ethnicity, or income level. The concept of accumulation refers to meeting the goal of 60 minutes per day by performing activities in multiple shorter bouts spread throughout the day (e.g. 2 bouts of 30 minutes), then adding together the time spent during each of these bouts (World Health Organization, 2010). However, a large worldwide population of children and adolescents is insufficiently active, not

achieving the PA recommendation of 60 minutes of daily MVPA (Currie et al., 2012; Hallal et al., 2012).

A current survey carried out by WHO revealed that 77-85% of European adolescents do not achieve 60 minutes of MVPA daily (Currie et al., 2012). Data from Health Behavior in School-aged Children study (HBSC), that included young people from 44 countries across the WHO's European Region and North America, reported that Portuguese adolescents showed a prevalence of low PA rates (A. Marques & Gaspar de Matos, 2014), with only 33.6% of Portuguese boys and 16.6% of girls between 11 to 15 years old being sufficiently active.

Likewise, another study performed with Portuguese youth suggested that only 36% of adolescents between 10-11 years old and 4% of 16-17 years of age meet the recommended levels of PA after using an accelerometer for four consecutive days (Baptista et al., 2012).

Taking into account the recommendations for young PA it is imperative to develop studies that provide accurate data of PA levels of Portuguese youth, focusing on the determination of the frequency and distribution of PA performed, analyzes of quantity and/or intensity necessarily to influence specific parameters in health, identify the psychosocial and environmental factors that influence the PA levels of youth and evaluate the effectiveness of programs aimed at increasing young people PA (Trost et al., 2002).

## 3. School Contribution for Physical Activity Levels

From a public health perspective considering the growing evidence that PA has decreased over the last decades (Yeung & Hills, 2007) (Cooper et al., 2015) schools are recognized as key points in providing and promoting PA (Kretschmann, 2014; Pate & O'Neill, 2008).

School is an institution that has a major effect on children and adolescents' lifestyle, including PA patterns. It "simply" plays a significantly influencing role in the daily routine of students. It also serves as a main socializing agent and socializing environment, especially in terms of exposure to PA (Gråstén, Watt,

Hagger, Jaakkola, & Liukkonen, 2015; Kretschmann, 2014). Furthermore, the school environment plays an important role in the prevention of obesity, intervening at food education and PA taste levels, especially through the curricular PE classes (Marina Marques, Felipe Fossati, & Pedro Curi, 2012). Many of the lifestyle choices and behaviors associated with obesity are developed during scholar ages, so feeding and PA are important determinants of youth body weight.

As young spend about half of their waking hours in school, for an increasing number of children, it provides the main opportunity for being physically active (R. Bailey, 2006; EU Working Group 'Sport & Health', 2008) and this might be even more relevant for OW children, who are generally less active than their NW counterparts (Cooper et al., 2015; Ekelund et al., 2004). Extracurricular sport participation, like sport club participation, after-school programs, or simply unorganized leisure time PA, has been shown to have an important relevance to the total time spent in daily MVPA (Viciana et al., 2015b), contributing with at least 50% of overall PA in children and adolescents(Tudor-Locke, Lee, Morgan, Beighle, & Pangrazi, 2006). However, these are freely chosen activities that are frequently selected by the active population and often do not catch-up those who need it most. Moreover, within the school day, PE classes and the recess represent the two most important contexts where children and adolescents have the opportunity to be physically active (Tudor-Locke et al., 2006). Studies have shown that youth habitual PA takes place between 35 - 53% during school hours (Timothy A. Brusseau & Hannon, 2013), presenting a significant role in young's overall PA (Stratton et al., 2008). Thus, the provision of a sufficient amount of PA during school may be one way to act effectively in changing PA patterns (Timothy A. Brusseau & Hannon, 2013; R. R. Pate et al., 2006).

### 3.1 Physical activity on Physical education classes

PE is considered as the best instrument within the educational field to potentiate young PA levels and promote heathy and active lifestyles (European

Commission/EACEA/Eurydice, 2013), and in fact, PE days as been shown to have higher values of PA than days without PE classes (Kretschmann, 2014; Meyer et al., 2013).

Every young can benefit from regular engagement in PA played in PE classes and, besides that, PE classes and their teachers have the responsibility to provide all youth, with meaningful, relevant and positive PE and PA experiences. Given this, it is unquestionable the role that PE can and should realistically, sensibly and safely play in addressing young OW and obesity (Cale & Harris, 2013).

The aims and purposes of PE have and continue to be widely debated and contested (Kirk, 2010; Penney & Chandler, 2000) and the purposes that have been cited are related to outcomes concerned with physical and social skills, moral values, spirituality, intellectual ability, health (including obesity), fitness or recreation (Cale & Harris, 2013; Thomas L. McKenzie & David Kahan, 2008). Thus, given that PE involves all young people, in regular PA, resulting in increased EE and potentially in health benefits, and provides opportunities for them to acquire and develop the skills and knowledge required to be physically active, it seems logical to play a part in addressing obesity and other health diseases related to low PA levels. Similarly, its role should be to stimulate interest, enjoyment, knowledge, understanding, competence and confidence in PA and sport for health and well-being. However, PE programs face numerous contests including pervasive inactivity among young and their families (Bevans et al., 2010; Nader et al., 2008), competing with other academic priorities (European Commission/EACEA/Eurydice, 2013; Russell R. Pate et al., 2006) and budget cuts (Thomas L. McKenzie & David Kahan, 2008). Eurydice Report developed in Europe countries with the purpose to analyze PE and sport at school in Europe as showed that as far as recommendations on minimum taught time in physical education are concerned big differences exist between European countries (European Commission/EACEA/Eurydice, 2013). However, compared to other subjects, PE allocation is still relatively low. In general, it corresponds to less than 10% of total taught time, or around half the time devoted to mathematics.

United States Department of Health and Human Services (2000), intended the initiative Healthy People 2010, that prescribe an increase in adolescents' participation in daily PE, recommending that 50% of PE class time should be spent in MVPA to promote health benefices in youth. However, PE is struggling to provide the frequency and intensity of PE and PA opportunities recommended in Healthy People 2010 (Bevans et al., 2010). Studies showed that only 3.8% of elementary, 7.9% of middle, and 2.1% of high schools provide daily PE for students in all grades for the entire school year (Thomas L. McKenzie & David Kahan, 2008). Although, students spend large amounts of PE class time being inactive (Ferreira et al., 2014; Viciana et al., 2015b), performing low levels of PA and engaging less than 50% of class time in MVPA (Meyer et al., 2013; Nettlefold et al., 2011).

The majority of PE studies have been carried out with observational methodology, recording the motor commitment times (focused on motor learning) without differentiating how much of that time is allocated to MVPA (Viciana et al., 2015b). Since technology allows, objective measurement studies have been carried out of PA in PE classes in international contexts (Kretschmann, 2014), obtaining around 30 minutes per session and a daily contribution to total PA around 20% (Slingerland, Borghouts, & Hesselink, 2012). In a study conducted with 676 children, aged between 5 and 13 years old, Meyer et al. (2013) analyzed the objective PA levels on PE classes and the contribution of PE to overall PA, obtaining low values of MVPA (32.8±15.1% of total PE time). However, this amount represented a significant percentage of the MVPA during the week (around 12%, 16 minutes more of MVPA in PE days, as did (David Martinez-Gomez, Tucker, Heelan, Welk, & Eisenmann, 2009); Trost et al. (2002) showed). Nevertheless, given the relatively low amount of MVPA that children and adolescents accumulate during a weekday (Meyer et al., 2013; Slingerland et al., 2012) the contribution of PE might still be substantial.

Therefore, it seems essential to study how schools, and in particular PE classes, can effectively contribute to the promotion of a more active and healthy lifestyle. Draw efforts to promote PA seems to be even more justified taking into account the growing concerns over the damaging effects of low PA levels and

sedentary lifestyles on the health of young. Despite this concern, to the best of our knowledge, few studies have been conducted in the school age regarding Portuguese young.

Thus, the aim of the present thesis was to study patterns of PA in classes with different duration (45PE and 90PE), analyze the contribution that PE give for total PA performed and understand the association between PA levels, gender and weight status.

# CHAPTER II – EXPERIMENTAL WORK

# 1. Methods

## 1.1 Study Design and Sampling

This study was conducted in several middle and high schools in Porto district and as a part of AFINA-te PROJECT STUDY (Physical Activity and Nutritional Information for Adolescents) a longitudinal study being developed in Porto area, Portugal, designed as an intervention project to promote nutritional knowledge and physical activity.

Participants in the study were recruited from different schools with the aim to maximize variance in environmental attributes. Twenty-five public schools within the Porto area (Portugal) were invited by mail and email to participate in the study. From these, 13 schools declined to participate, 6 didn't reply to our invitation and 6 schools agreed to take part in this study.

The school, parents and all young received a written description of the study. Respondents included children and adolescents, aged between 10 and 18 years, properly enrolled in 5th- to 12th- grade classes, who agreed to participate and had parental written consent to take part in this cross-sectional study.

The procedures used in this study have followed the principles of the Declaration of Helsinki. Ethical approval was obtained from the Faculty of Sports ethics committee, the Portuguese Foundation for the Science and Technology and by the regional section of the Ministry of Education.

## 1.2 Anthropometric measures

Body mass and height were evaluated in accordance with standard procedures. Weight was measured to the nearest 0.10 kg, with participants lightly dressed (underwear and t-shirt) using a portable digital scale (Tanita Inner Scan BC 532, Wembley, UK). Height was measured to the nearest 0.01 m in bare or stocking feet with children standing upright against a SECA 217 portable stadiometer. Body Mass Index (BMI) was calculated from the children's height and weight [weight (Kg)/height2(m)]. The classification of students' BMI was performed according to the internationally agreed procedures proposed by Cole (2000) considering the children's and adolescent's age and gender, in order to be classified as normal, overweight and obese. Thus, in our study children were

categorized as non-obese group (NOW), and overweight/obese group (OW), according to the age and sex-adapted values (Cole, 2000).

### 1.3 Physical Activity

PA was measured using the Actigraphs accelerometers, model GTM1 and wGT3X-BT (Pensacola, FL, USA). The accelerometer was placed on the right side of the waist, and participants were instructed to use it all day over 7 consecutive days. After collecting, the data have been downloaded to the Actilife software where they were processed. Initially, wear use time was validated, checking that the device was used/ unused and differentiating time to sleep/physical activity according to the algorithm developed by Choi, Zhouwen, Matthews, and Buchowski (2011). A minimum recording of 480 minutes per day was established to accept the data as a valid daily PA, and the 7 evaluated days having at least 4 days of valid use. A minimum of 4 measurement days has been recommended to reach a sufficient reliability, i.e., an intraclass correlation coefficient (ICC) of 0.8 among days (Trost, Pate, Freedson, Sallis, & Taylor, 2000a). To evaluate the PA performed on PE the data was filtered according to the schedule of PE classes attended.

Data were analyzed in accordance with specific cut-off points (in counts per minute) developed by Evenson, Catellier, Gill, Ondrak, and McMurray (2008) considering the following intervals to determine the time spent in PA at different intensities: sedentary activity - 0 to 100; Light - 101 to 2295; Moderate - 2296 to 4011; Vigorous - more than 4012. To study effects the MVPA was considered from 2296.

### 1.4 Physical Education Classes

The PE classes observed form part of the regular school curriculum defined by the Ministry of Education and Science and are carried out twice a week, by a specialized physical education teacher. To assess “normal” nonintervened PE, no instructions were given regarding the content of those

lessons. The content of class was recorded because it is known that it can be determinant for the PA intensity.

We observed students' behavior into the two PE classes that they have during the week, for a total of 119 PE classes and later the mean percentage of the PA developed was calculated. Each session of 45PE has a duration lasting 20 to 49 minutes (mean: 31.68±6.48) and 90PE has a class duration ranging 42 to 84 minutes (mean: 66.20±7.23). The PE class time record was set when at least 51% of the students were present and the class record was ended-up when at least 51% left the PE setting. This record was used to calculate the duration of each class. The measure of the outcome (mean proportion of class time spent in PA) was obtained by dividing the mean class time spent in PA by the mean total duration of the classes.

### 1.5 Statistical Analyses

All statistical analysis were performed using statistical software SPSS® 20.0. The level of significance for all analysis was set at 0.05.

A descriptive analysis (means and sd.'s) was calculated to describe young's characteristics.

The basic information of the participant, variables and statistical analyses used in each paper of this thesis are presented in figure 1. Detailed methodological procedures concerning sample size, variables assessment and statistical procedures can be found at the materials and methods section of each paper.

**Table 1**. Summary of the characteristics of the papers integrated in the dissertation.

| Original Work | Sample Size | Mean Age | Studied variables | Statistical Analyses |
|---|---|---|---|---|
| **Paper I** | | | | |
| *Physical activity levels, patterns of moderate to vigorous physical activities in physical education classes and compliance with guidelines for Youth: differences in a 45 and 90 minutes Physical Education Lessons.* | 472 young (206 boys 266 girls) | 14.4 years | Physical Activity - Recommendations<br>Physical Education Classes - 45PE and 90PE<br>Gender | One-way analyses of covariance (ANCOVA)<br>One-way repetead measures ANOVA<br>Post-hoc pairwise comparisons Bonferroni correction<br>One sample t-test |
| **Paper II** | | | | |
| *Objectively measured physical activity levels in physical education classes and body mass index* | 472 young (206 boys 266 girls) | 14.4 years | Physical Activity - Recommendations<br>Physical Education Classes - 45PE and 90PE<br>BMI | One-way analyses of covariance (ANCOVA)<br>One sample t-test<br>Independent Sample T- Test<br>Binomial Logistic Regression |
| **Paper III** | | | | |
| *Contribution of Physical Education Class with different durations for the Daily Physical Activity* | 441 young (188 boys 253 girls) | 14.3 years | Physical Activity - PED45, PED90, NPED and WD - Recommendations<br>Physical Education Classes - 45PE and 90PE | One-way analyses of covariance (ANCOVA)<br>One-way repetead measures ANOVA<br>Post-hoc pairwise comparisons Bonferroni correction<br>Binomial Logistic Regression |

BMI: body mass index.

# CHAPTER III – PAPERS

**PAPER I**

# Physical activity levels, patterns of moderate to vigorous physical activities in physical education classes and compliance with guidelines for Youth: differences in a 45 and 90 minutes Physical Education Lessons

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**Abstract**

Background: The current recommendations for physical activity (PA), in school-aged children and adolescents, advocate 60 minutes of daily moderate to vigorous PA (MVPA) in order to obtain healthy benefits. However, young show low participation in daily MVPA and high levels of inactivity and sedentary behavior. School-based Physical Education (PE) is the most widely available source to promote structured PA among young and the guidelines recommend that at least 50% of class time should be spent in MVPA, though few studies on this assumption have been conducted. The objective of this study was to analyze, comparatively, PA levels in 45 and 90 minutes PE classes (45PE and 90PE), their relative contribution for the compliance of the daily recommendations for MVPA and the differences between genders.

Participants and Setting: This study was conducted in four randomly selected Portuguese public schools. The sample comprised 472 young volunteers aged between 10 and 18 years (14.43 ± 2.79), composed by 206 boys and 266 girls. PA was assessed using an Actigraph accelerometer and activity was measured as counts per minute.

Data collecting: We observed students' behavior into the two PE classes that they have during the week, for a total of 119 PE classes, 23 45PE classes and 96 90PE classes, and later the mean percentage of the PA developed was calculated.

Data analysis: All data were analyzed by statistical software SPSS® 20.0 for a significance level of 5%.

Findings: There was no difference in the PA realized in PE classes with different durations (45PE and 90PE), except for Sedentary Behavior (SB) which is higher in 90PE than in 45PE. The proportion of MVPA is lower than the 50% recommended by guidelines and participants who meet the recommendations do it just above the reference value and those that don't meet the recommendations only reach half of the recommended amount. Furthermore, boys spent significantly more time engaged in MVPA and girls spent more time in SB and Light Physical Activity (LPA).

Conclusion: Longer lessons do not necessarily produce more MVPA. Also, during PE class youngsters spent a reduced amount of time engaged in MVPA.

**Keyword:** Children and adolescents; guidelines and recommendations; accelerometry; physical activity; physical education.

**Summary**

This study presents some novelty in its approach due to the lack of information about PA objectively evaluated during PE and the scarce research focused on the comparison of classes with different durations. We found low levels of moderate to vigorous physical activity (MVPA) in 45 and 90 minutes physical education (PE) classes and no differences were found in the MVPA realized in classes with different duration. So, our study suggests that longer lessons may not necessarily produce more MVPA and to have health benefits children and adolescents should have daily PE classes. To increase MVPA in PE classes it seems to be important to increase teacher awareness about the association between time spent in lesson contexts, promotion of PA, and student engagement in MVPA, which is essential for fitness development.

## Introduction

There is scientific evidence that decreasing levels of physical activity (PA) and low fitness levels are related to the prevalence of obesity and other metabolic diseases (Janssen & Leblanc, 2010; Ortega et al., 2013), which are precursors of adult chronic diseases (Ekelund et al., 2012; Kavey et al., 2003). Thus, the priorities of international public health recommendations call for an increase of moderate to vigorous activities (MVPA) and physical fitness targeting health benefits (Kriemler et al., 2010; World Health Organization, 2012). Current guidelines for PA suggest that children and adolescents should accumulate at least 60 minutes of MVPA daily (Currie et al., 2012; World Health Organization, 2010). However, evidence has suggested that the majority of children and

adolescents do not achieve those recommendations (Russell R. Pate et al., 2006) showing that only one third of European children and adolescents are sufficiently physically active (Ekelund et al., 2012).

School is the privileged setting to intervene because it can involve and influence a large number of children with low cost and within family proximity (Beets & Pitetti, 2005). Indeed, schools can provide many opportunities for young people to engage in PA and can play an important role in motivating young people to stay active (Jaakkola, Liukkonen, Laakso, & Ommundsen, 2008). In addition, PE classes represent a moment where children and adolescents can engage in PA of sufficient quantity and quality to promote health-related benefits, providing opportunities to be physically active and teaching them the knowledge and movement skills can lead to active lifestyles (S. Fairclough & G. Stratton, 2005; Sanchez-Vaznaugh et al., 2012). Since most youth attend school, the role of PE in the development of PA behavior, and subsequent physical fitness, became a central principle in reducing sedentary behavior (Bevans et al., 2010). However, PE faces numerous challenges including pervasive inactivity among children and families, competing with academic priorities and budget limitations (Bevans et al., 2010; Russell R. Pate et al., 2006). United States Department of Health and Human Services (2000) intended the initiative Healthy People 2020, recommending that PE is offered daily and 50% of PE class time should be spent in MVPA to promote health benefices in youth. Actually, the literature in the field is scarce and the variety in the methods for the assessment of PA is spread (S. J. Fairclough & G. Stratton, 2005; Stuart J. Fairclough & Gareth. Stratton, 2006). In most of the studies, the methods of PA assessment vary from systematic observation through heart rate monitors, pedometry and accelerometry (S. J. Fairclough & G. Stratton, 2005; Stuart J. Fairclough & Gareth. Stratton, 2006). Although methodological limitations, studies have found low levels of PA in school PE classes, especially of MVPA (Ferreira et al., 2014; Viciana et al., 2015b), with students engaging less than 50% of class time in MVPA (Meyer et al., 2013; Nettlefold et al., 2011). Actually, in Portugal, elementary school curriculum orders that students have 135 minutes of PE per week, preferentially three 45 minutes PE periods. However, schools can adjust that and the major of them prefer to

distribute PE time in two PE classes, one session lasting 45 minutes and other lasting 90 minutes. At our knowledge few studies have investigated whether children and adolescents engage in more PA comparing 45PE with 90PE classes (single or double period).

So, taking into account that many variables could be considered determinants to PA levels during PE classes: students' age, gender, and grade, teachers' experience and attitudes, curricular content, duration of classes, equipment availability, facilities and others (Bevans et al., 2010; Cohen et al., 2008), with this study we aimed at investigating how some of these determinants, specifically gender and classes duration, associate with PA objectively measured by accelerometers during 45PE and 90PE, controlling for others covariates.

## Material and Methods

### *Participants and data collection*

This was a cross-sectional study completed in elementary and secondary schools as a part of AFINA-te PROJECT STUDY (Physical Activity and Nutritional Information for Adolescents) a longitudinal study developed in the Porto area, Portugal, designed as an intervention project to promote nutritional knowledge and physical activity. Twenty-five public schools within the Porto area (Portugal) were invited by mail and email to participate in the study. From these, 13 schools declined to participate, 6 did not reply to our invitation and 6 schools agreed to take part in this study.

Respondents included 603 children and adolescents who agreed to participate and had parental written consent to take part in the study. After eliminating individuals who did not attend PE classes, the final sample comprised 472 youngsters (29.8%; 206 boys and 266 girls) aged between 10 and 18 years (mean: 14.43 ± 2.79).

Ethical approval for this study was obtained from the Faculty of Sports ethics committee, the Portuguese Foundation for the Science and Technology and by the regional section of the ministry of Education.

### *Physical Activity*

PA and MVPA during PE classes were measured using the Actigraphs accelerometers, model GT3X (Pensacola, FL, USA). For the purpose of this study, epoch duration or sampling period was set to 5s. The accelerometer was fixed on the students' waist from the beginning to the end of the PE class. After collecting, the data have been downloaded to the software Actilife where they were processed. Initially, wear/ use time was validated, checking that the device was used/ unused and differentiating time to sleep/physical activity according to the algorithm developed by Choi et al. (2011). Afterwards the data was filtered according to the schedule of PE classes attended. Finally data were analyzed in accordance with specific cut-off points (in counts per minute) developed by Evenson et al. (2008): sedentary activity - 0 to 100; Light - 101 to 2295; Moderate - 2296 to 4011; Vigorous - more than 4012. To study effects the MVPA was considered from 2296.

### *Physical Education Classes*

The PE classes observed form part of the regular school curriculum defined by the Ministry of Education and Science and are carried out twice a week, by a specialized physical education teacher. To assess "normal" nonintervened PE, no instructions were given regarding the content of those lessons. The content of class was recorded because it is known that it can be determinant for the PA intensity.

We observed students' behavior into the two PE classes that they have during the week, for a total of 119 PE classes, 23 45PE classes and 96 90PE classes, and later the mean percentage of the PA developed was calculated. Each session of 45PE has a duration lasting 20 to 49 minutes (mean: 31.68±6.48) and 90PE has a class duration ranging 42 to 84 minutes (mean: 66.20±7.23). The PE class time record was set when at least 51% of the students were present and the class record was ended-up when at least 51% left the PE setting. This record was used to calculate the duration of each class. The measure of the

outcome (mean proportion of class time spent in PA) was obtained by dividing the mean class time spent in PA by the mean total duration of the classes.

***Statistical Analysis***

A descriptive analysis (means and standard deviations) was calculated to describe participant's characteristics. For data analysis, we have checked the normal distribution of variables. The average percentage spent in sedentary behavior and light, moderate and vigorous physical activity during the 45 and 90 minutes PE classes was examined using a general linear model. To compare the percentage spent in sedentary behavior and light, moderate and vigorous physical activity during 45 and 90 minutes PE classes we used a general linear model – repeated measures and the association between PA intensities and gender were analyzed through a general linear model (GLM) - ANCOVA. Each model was adjusted for age and class content, as these can be considered confounding variables. Initially, we tested the influence of both variables and when some was not significant it was removed from the model. The comparisons between compliance with MVPA in PE classes' recommendations (more than 50% of class time in MVPA) were evaluated with one sample t-test. The comparisons between contributions of PE classes to the compliance of daily PA recommendations (% of time that PE classes contribute for the compliance of 60 minutes of MVPA per day) were calculated using an Independent T-Test. All data were analyzed by statistical software SPSS® 20.0 for a significance level of 5%.

**Results**

Table 1 [Table 1 near here] shows descriptive statistics of PA during PE, according to gender. There were no differences in the mean percentage of PA levels in 45PE and 90PE ($p>0.05$), except for SB ($p<0.05$) wich is higher in 90PE than 45PE (17.33% vs 11.08%, respectively). Overall, mean time spent in MVPA during 45PE was 10.19±6.21 minutes and in 90PE it was 20.00±11.87 min., corresponding to 32.2% and 30.35% of the total time for 45PE and 90PE, respectively. In general, participants did not meet the recommendation of 50% PE in MVPA, either in 45PE or 90PE ($p<0.05$). In addition, as shown in figure 1,

only 20% of students meet the recommendations for MVPA in 45PE while for 90PE only 15% of students achieved that goal.

Analyzing by gender, the percentage of boys that meet the recommendations for MVPA in 45PE is 26%, the mean percentage of MVPA is 62.9%. In 90PE classes only 28% of boys meet the recommendation, with 61.3% of mean percentage of MVPA. Regarding girls, the percentage that meets the recommendations in 45PE is 15%, with 61.6% of mean percentage of MVPA. In 90PE classes, only 5% of girls meet the recommendation, with 61.3% of mean percentage of MVPA. On average, boys were significantly more engaged ($p<0.05$) in MVPA than girls during both 45PE (11.78 min vs 8.97 min) and 90PE (25.69 min vs 15.63 min). In contrast, girls spent more time than boys in sedentary (13.14 min vs 9.93 min, $p<0.05$) and light PA in 90PE (36.83 min vs 30.84 min, $p<0.05$).

Table 2 [Table 2 near here] shows that 90PE has a higher contribution ($p<0.05$) for daily MVPA recommendations compliance than 45PE (33.33% vs 16.99%) both in boys (42.82% vs 19.63%) or in girls (26.05% vs 14.94%).

**Discussion**

This study aimed to objectively assess the PA levels during 45PE and 90PE, respectively. In addition, we also assessed the compliance with MVPA recommendation during PE classes as well as the contribution of PE classes to the compliance with daily MVPA recommendations. This study presents some novelty in its approach due to the lack of information about PA objectively evaluated during PE (S. J. Fairclough & G. Stratton, 2005) and the scarce research focused on the comparison of classes with different durations. Furthermore, the information provided by the major of studies realized it is not explicit about the full length (45 minutes vs. 90 minutes) or useful PA task time (usually 30 min vs. 75min). Several studies concluded that 31% of the 45PE class was used to equip and shower (McKenzie et al., 2000). Also, a study from Portugal (Wang, Pereira, & Mota, 2005) indicates that between 32% and 36% (90 min vs. 45 min) class time is used to equip and bathing and a more recently published study (Smith, Lounsbery, & McKenzie, 2014) confirms that 35% of

class time is spent in the bathing resort. Therefore, in our approach we used the real class time and to calculate the duration of each class the register was set when at least 51% of the students were present and the class evaluation was ended-up when at least 51% left the PE setting. Each session of 45PE has a mean duration of 32 minutes and 90PE has a mean duration of 66 minutes. Changing clothes, bathing and students' displacement to the PE class performing space can explain the difference between the time available and the real class time.

Our data suggest that there was no statistic difference in the PA realized in PE classes with different durations (45PE and 90PE; $p>0.05$), except for SB which is higher ($p<0.05$) in 90PE than in 45PE (17% of total class time and 11%, respectively). Similar results were found in recent study realized in Portugal (Ribeiro, 2014), and in a study conducted in California (Smith et al., 2015) suggesting that more total class time does not necessarily correspond to more time spent being active, in MVPA. According to Smith et al. (2015), the teacher characteristics and lesson-level pedagogical factors largely controlled by the teacher including the percentage of time spent changing clothes at the start and end of class, how time was spent in lesson contexts, teacher promotion of PA, and lesson location may explain the variability of PA realized in PE classes with different lengths. Importantly, most of these factors were associated with teacher classroom management. So, it seems to be important to increase teacher awareness about the association between time spent in lesson contexts, promotion of PA, and student engagement in MVPA, which is essential for fitness development (Lonsdale et al., 2013). Another study, realized in Germany (Kobel, Kettner, Erkelenz, Kesztyüs, & Steinacker, 2015), focused on the investigation whether children accumulate more time in MVPA during multiple single PE lessons compared with double periods of PE have found similar results to ours, suggesting that with regards to accumulation of MVPA during PE children benefit more from single lessons of PE than from double periods. The literature does not offered, at this time, an explanation for these conclusions, but children and adolescents seem to do more intense PA in the limited time of 45PE classes,

taking advantage of the lower class time to be more physically active, than in the 90PE classes.

Furthermore, this study showed that during PE class youngsters spent a reduced amount of time engaged in MVPA. Indeed, only 32.2% of class time on 45PE was spent in MVPA while 30.4% in 90PE (see Table 1); not meeting the recommended 50% of lesson time criterion (United States Department of Health and Human Services, 2000). Also, only 20% of participants meet the recommendations for the MVPA in 45PE and 15% in 90PE ($P<0.05$). As we can see in Figure 1 [Figure 1 near here] the mean of MVPA in the 45 and 90 minutes PE classes of participants that meet the recommendations is lightly above the recommended value (62.3% and 60.7%, respectively; $p<0.05$). However, the mean of MVPA in the 45PE and 90PE of participants that do not meet the recommendations is markedly below the value recommended for the MVPA in the PE classes (24.7% and 25%, respectively; $p<0.05$). When we analyze the data by gender, the results are similar ($p<0.05$). This suggests that participants who meet the recommendations do it just above the reference value and those that don't meet the recommendations only reach half of the recommended amount. Our study, as some previous mentioned, showed large standard deviation suggesting wide individual variations in MVPA values. This indicates that some students spend a great deal of class time engaging in MVPA while others stay mostly inactive. Such variation in activity levels reflects the influence of contextual and pedagogical factors of PE classes (i.e. lesson objectives, content, environment, teaching styles …) (Bevans et al., 2010).

When we compare our results with the data founded in previous studies, this proportion is lower than the percentages of 46.8% (S. J. Fairclough & G. Stratton, 2005) and 43.5% (Lonsdale et al., 2013) reported by accelerometry in same studies. However, other recent studies have found similar results to ours with percentages of 28.18% (Ferreira et al., 2014), 32.7% (Kremer, Reichert, & Hallal, 2012) 32.8% (McKenzie et al., 2006) and 37.9% (Susana Vale, Rute Santos, Luísa Soares-Miranda, Pedro Silva, & Jorge Mota, 2011) of MVPA in PE classes.

Recently, in Portugal, we witnessed changes in educational policies with the curriculum undergoing important adjustments. In a country with the obesity prevalence rate increasingly higher, the PE curricular unit saw its frequency and duration being reduced in favor of other subjects. Actually, during elementary school, students have 135 minutes of PE per week, normality distributed in two PE classes, one session lasting 45 minutes and other lasting 90 minutes. Concerning secondary school students, have 180 minutes of PE per week, dispersed in two 90-minutes PE classes. However, regarding this last one the PE lessons are no longer considered in the final average of the students. This devaluation of the curricular unit may be related to the minor relevance that the students give it, as well as their lower commitment and participation in class.

Comparing the data collected with the recommendation that children and adolescents should have at least 60 minutes of daily MVPA, we conclude that 45 minutes PE lessons contribute 16.9% and 90 minutes lessons contribute 31.7% to the 60 minutes daily of MVPA. These results are similar to results found in other studies that show percentages of 29% (S. J. Fairclough & G. Stratton, 2005), 20.5% (Kremer et al., 2012) and 42% (Ferreira et al., 2014) of PE classes' contribution to the 60 minutes of MVPA. As we can see, the results are still far below expectations. Maybe the strategies and goals for PE are outlined incorrectly or it is possible that the PA implemented outside of PE class represents a leading role in achieving the recommended time of 60 minutes a day of MVPA. Only data collected in the various studies conducted may contribute to the answer.

In our study, we intend to fully characterize the PA during PE class and therefore its relationship with gender. Therefore, our results suggest that boys were more active and participative in PE lessons than girls, engaging in more ($P < 0.05$) MPA, VPA and MVPA in 45 and 90 minutes classes. Simultaneously, girls spent more time in SB and LPA during the class period than boys. Others studies have shown that boys are more active than girls in PE classes (Ferreira et al., 2014; Susana Vale et al., 2011). Two studies led in Portugal (Almeida, 2011; Ribeiro, 2014) comparing the PA accomplished in classes with different duration (45 and 90 minutes) have found similar results to ours.

Some factors may be influencing this MVPA difference between the genders, including the kind of content covered, biological and motivational differences between genders, the expectations created by society and by their peers (S. Fairclough, 2003). PA is what makes PE classes different from the others disciplines. Maybe some PE activities do not encourage girls to engage in the same way that boys do. Some studies suggest that girls may not like to exercise themselves intensely during PE classes (McKenzie et al., 2006), perhaps because they are less motivated than boys (S. Fairclough, 2003). It is important to consider if we want PE lessons to be able to engage and captivate students and contribute for them to be physically active. There is evidence that environmental factors, such as class size, location and class contexts influence the activity of young people and that there are clear policy implications for the PE class organization, which emphasize the need to create strategies to maximize MVPA participation (Skala, Springer, Sharma, Hoelscher, & Kelder, 2012).

Little is known whether PE promotes activities with intensity, duration and frequency sufficient to bring health benefits to students. The few studies found indicate that PE classes have short periods of sufficient intensity to cause physiological adaptations in students (Hino et al., 2007). The low proportion of time spent in class in physical efforts with sufficient intensity to promote physiological adaptations, as well as short duration of these stimulus is an important finding, but not sufficient. Knowledge about the classes and teaching programs of school PE is still limited. New studies seeking to identify factors that influence the development of classes, as well as the determinants of physical activity practice of students in PE classes, should be performed. The reforms carried out by the Portuguese Government, reducing the length and number of PE classes to the detriment of the curriculum requirements of other disciplines should be rethought because, as we can see, youngsters need more quality and quantity of PA to adopt a healthy lifestyle.

Some limitations of the study should also be recognized. The study included school children and adolescents from a metropolitan area only, which makes difficult to generalize the findings. Further, it is not possible to infer causal relationships with a cross-sectional design.

## Conclusion

Our findings suggest that longer lessons do not necessarily produce more MVPA, and that the proportion of MVPA in 45 and 90 minutes PE classes is lower than the 50% recommended by guidelines with only 20% of students to comply the recommendations in the 45PE and 15% in the 90PE. Furthermore, boys spent significantly more time in MVPA than girls. In contrast, girls spent more time in SB and LPA than boys.

These findings have important policy implications for the organization of PE classes, emphasizing the need to create strategies to maximize MVPA participation, whether it is in PE classes, where teachers must be aware of the importance of promoting PA, providing students opportunities to improve their skills and contributing to ensure physically activeness, or providing non-competitive extracurricular programs which also have potential to increase MVPA accumulated during the school day. The perceived difference between recommended PA levels and the limited curriculum time for PE should be considered because perhaps this is compromising the PA opportunities for youths.

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Table 1. Descriptive statistics of study participants.

| | All Sample (n=472) | P-value | Girls (n=266) | Boys (n=206) | P-value |
|---|---|---|---|---|---|
| Age (years) | 14.43±2.79 | | 14.49±2.71 | 14.34±2.89 | 0.578 |
| Weight (Kg) | 56.42±14.40 | | 54.33±11.39 | 59.12±17.20 | **0.000** |
| Height (cm) | 159.24±12.19 | | 156.42±8.46 | 162.894±15.00 | **0.001** |
| BMI (Kg/m$^2$) | 22.01±3.94 | | 22.12±3.90 | 22.87±3.40 | 0.507 |
| SB (minutes) | | | | | |
| *45 min. Classes* | 3.55±3.62 | | 3.88±3.57 | 3.12±3.67 | 0.056 |
| *90 min. Classes* | 11.75±11.44 | | 13.14±11.72 | 9.93±10.82 | **0.002**[a] |
| LPA (minutes) | | | | | |
| *45 min. Classes* | 17.75±6.94 | | 17.98±6.67 | 17.45±7.31 | 0.363 |
| *90 min. Classes* | 34.23±11.08 | | 36.83±10.36 | 30.84±11.03 | **0.000**[b] |
| MPA (minutes) | | | | | |
| *45 min. Classes* | 6.40±4.09 | | 5.73±3.72 | 7.27±4.41 | **0.031** |
| *90 min. Classes* | 12.35±7.21 | | 10.38±6.30 | 14.91±7.51 | **0.000**[a] |
| VPA (minutes) | | | | | |
| *45 min. Classes* | 3.79±4.22 | | 3.22±4.18 | 4.52±4.21 | **0.008** |
| *90 min. Classes* | 7.70±8.08 | | 5.32±10.77 | 10.79±10.29 | **0.000**[a] |
| MVPA (minutes) | | | | | |
| *45 min. Classes* | 10.19±6.21 | | 8.97±5.48 | 11.78±6.74 | **0.005**[a] |
| *90 min. Classes* | 20.00±11.87 | | 15.63±8.81 | 25.69±12.91 | **0.000** |
| Physical Activity Patterns | | | | | |
| *SB* | | | | | |
| *45 min. Classes* | 11.08±10.80 | **0.046** | 12.42±10.79 | 9.05±10.71 | 0.069[c] |
| *90 min. Classes* | 17.33±15.99 | | 19.54±16.38 | 14.44±15.02 | **0.001**[a] |
| *LPA* | | | | | |
| *45 min. Classes* | 56.14±19.68 | 0.489 | 57.23±18.99 | 54.22±20.53 | 0.471 |
| *90 min. Classes* | 52.00±16.54 | | 56.23±15.20 | 46.48±16.66 | **0.000**[a] |
| *MPA* | | | | | |
| *45 min. Classes* | 20.52±12.96 | 0.489 | 18.67±12.23 | 22.92±13.56 | **0.025** |
| *90 min. Classes* | 18.79±10.92 | | 15.84±9.58 | 22.63±11.36 | **0.000**[a] |
| *VPA* | | | | | |
| *45 min. Classes* | 11.68±13.22 | 0.066 | 10.36±13.71 | 13.38±12.45 | 0.393 |
| *90 min. Classes* | 11.63±11.96 | | 8.12±7.00 | 16.20±15.17 | **0.000**[a] |
| *MVPA* | | | | | |
| *45 min. Classes* | 32.20±19.34 | 0.115 | 29.02±18.42 | 36.29±19.87 | **0.041** |
| *90 min. Classes* | 30.35±17.65 | | 23.84±13.40 | 38.83±18.92 | **0.000**[a] |

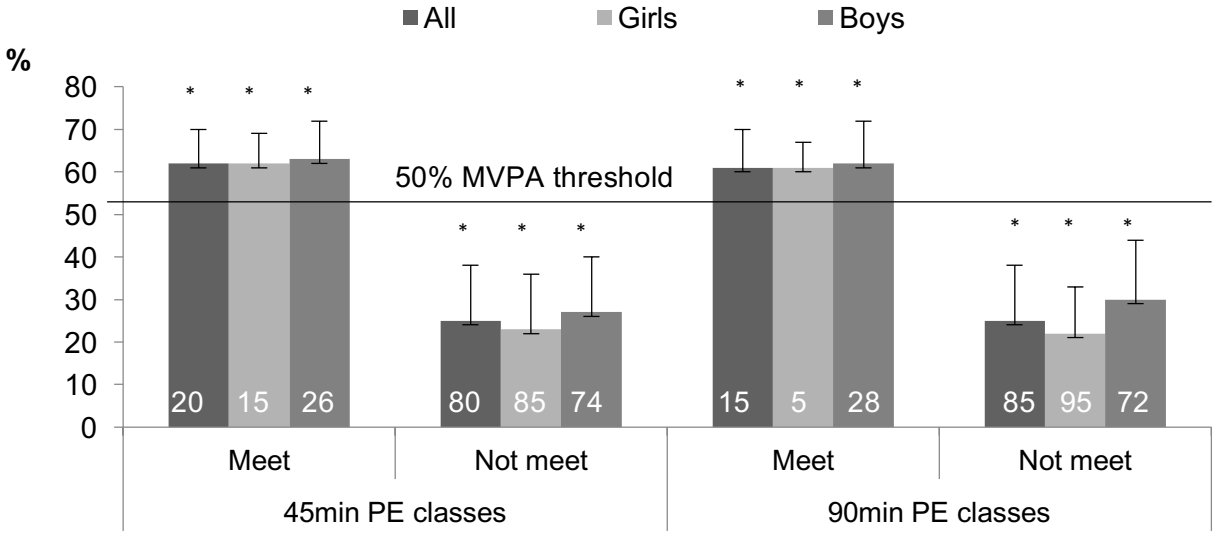
BMI: body mass index; SPA: Sedentary Physical Activity; LPA: Light Physical Activity; MPA: Moderate Physica ctivity; VPA: Vigorous Physical Activity; MVPA: Moderate and Vigorous Physical Activity. Data are expressed a leans and standard deviations. Bold text indicates significant P values ($p<0.05$). [a] Adjusted values for age. [b] Adjuste alues for age and modality practiced in the class. [c] Adjusted values for modality practiced in the class.

**Table 2.** Contribution that PE classes gives to the compliance of daily MVPA recommendations (60 minutes of MVPA per day).

| | All Sample (n=472) | P-value | Girls (n=266) | Boys (n=206) | P-value |
|---|---|---|---|---|---|
| MVPA (%) | | | | | |
| *45PE* | 16.99±10.34 | **0.000** | 14.94±9.14* | 19.63±11.23* | **0.005**[a] |
| *90PE* | 33.33±18.64 | | 26.05±14.69 | 42.82±21.52 | **0.000**[b] |

MVPA: Moderate and Vigorous Physical Activity. Data are expressed as means and standard deviations. Bold text indicates significant P values ($p<0.05$). [a] Adjusted values for age. [b] Adjusted values for age and modality practiced in the class. *Significant differences between 45 and 90 minutes PE classes in each gender.

**Figure 1.** Compliance with MVPA recommendations for PE classes in 45PE and 90 PE in boys and girls. *Significant differences between the mean percentage of MVPA in PE classes and the recommendations of 50% of the class time in MVPA. At the bottom of the column are the values of the percentage of participants who meet or do not meet the recommendations.



**PAPER II**

# Objectively measured physical activity levels in physical education classes and body mass index

# Niveles de actividad física medida objetivamente en las clases de educación física y el índice de masa corporal

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Objective: The objective of this study was twofold. First, analyze physical activity (PA) levels during physical education (PE) with different durations (45 and 90 minutes) according to student's obesity status. Secondly, we examine the relative contribution of 45 and 90 minutes PE for the compliance of the daily PA recommendations according to the body mass index (BMI). Methods: Four public schools were analyzed. The sample comprised 472 youngsters (266 girls) aged between 10 and 18 years old. PA was assessed using an Actigraph accelerometer. The participants were categorized as non-overweight (NOW) and overweight/obese (OW) according to the sex-adjusted BMI. Results: The proportion of Moderate and Vigorous Physical Activity (MVPA) was lower than the 50% recommended by guidelines regardless the PE duration. Our data showed that only 26% of NOW and 13% of OW in the 45PE achieved the recommended levels while 17% of NOW and 11% of OW achieved the recommendation in 90PE. Overall the 90PE had a higher contribution for daily MVPA recommendations compliance than 45PE. Conclusion: During PE classes youngsters spent a reduced amount of time in MVPA, independently of their weight status.

Keyword: Accelerometer, Physical Activity; Physical Education; Obesity; Young.

Objetivo: Este studio tiene un doble objetivo. En primero llugar, analizar los niveles de la actividad física durante la educación física con diferentes duraciones (45 y 90 minutos) de acuerdo con el estado de la obesidad de los alumnos. En segundo llugar, se analiza la contribución relativa de 45 y 90 minutos de la educación física para el cumplimiento de las recomendaciones diarias de atividade fisica según el índice de masa corporal. Métodos: cuatro escuelas públicas fueran analizados. La muestra fue de 472 jovenes (266 chicas) de edades comprendidas entre los 10 y 18 años de edad. Atividad física fue medida utilizando un acelerómetro Actigraph. Los participantes se clasificaron a la sin sobrepeso y con sobrepeso/obesidad de acuerdo con el índice de masa corporal ajustado al género. Resultados: La proporción de la actividad física moderada y vigorosa fue inferior al 50% recomendado por las guidelines, independientemente de la duración de la classe de educacion fisica. Los nuestros datos muestran que solo el 26% de los niños sin sobrepeso y el 13% de ninõs con sobrepeso/obesidade llegaron al los niveles recomendados en las classes de 45 min, mientras el 17% de los jovenes sin sobrepeso y el 11% con sobrepeso/obesidad han logrado las recomendaciones en las classes de 90 min. En general, las classes de 90 min tienen una mayor contribución para cumplimiento de las recomendaciones diarias de atividad física moderada a vigorosa do que las classes de 45 min. Conclusión: Durante las clases de educacion fisica los jóvenes an gasto una cantidad reducida de tiempo en atividad física moderada a vigorosa, independientemente de su estado de peso.

Palabra clave: Acelerómetro, actividad física; educación física; obesidad; Jovenes.

## Introduction

Worldwide, physical inactivity causes 6–10% of cases of coronary heart disease, diabetes and breast and colon cancer and 9% of premature mortality. Data from the WHO European Childhood Obesity Surveillance Initiative (COSI) show that, in some countries, more than 40% of 7- and 8-year-old boys are overweight and more than 20% are obese, while in Portugal, a prevalence of 27.3 % to 33.6 % of excess weight/obesity was found (Antunes & Moreira, 2011).

The need to develop and implement strategies for primary prevention of obesity and cardiovascular diseases in early ages is well recognized (Kavey et al., 2003). Indeed, in youngsters, there is enough evidence pointing out that those whom gather larger amounts of moderate to vigorous physical activity (MVPA) demonstrate lower levels of body fatness and clustered metabolic risk (Lars Bo Andersen et al., 2006; Ekelund et al., 2012).

The school may be a primary setting in preventing obesity, intervening on the level of food education and taste for exercise, especially through the curricular PE classes (European Commission/EACEA/Eurydice, 2013; Sallis et al., 2012a). Indeed, for many youngsters, school activities are the only one opportunity to develop significantly PA levels (Sanchez-Vaznaugh et al., 2012). Besides, PE is the school signature that promotes PA among students. The guidelines for PE indicate that 50% of PE class time should be spent engaged in MVPA to promote health benefits (United States Department of Health and Human Services, 2000). However, generally studies found low levels of PA in school PE classes, especially of MVPA (Stuart J. Fairclough & Gareth. Stratton, 2006; Viciana, Martínez-Baena, & Mayorga-Vega, 2015a), with students engaging less than 50% of class time in MVPA (Ferreira et al., 2014; Kremer et al., 2012). For instance, values around 30 minutes per class, with a daily contribution for the total PA around 20, were described previously (Slingerland et al., 2012; Viciana et al., 2015a). In Portugal some studies have been conducted to investigate the intensity of PA realized in PE, but few studies analyze PE classes with different duration and their relation with weight status of children and adolescents. Therefore, the purpose of this study was to examine the association between objectively measured PA during PE with different durations and weight status of

Portuguese students as well as to assess the compliance with MVPA recommendation during PE classes. Furthermore, we also analyze the contribution of PE for the accomplishment of the daily MVPA recommendations, taking into account BMI.

## Material and Methods

### Participants and data collection

This was a cross-sectional study completed in elementary and secondary schools as a part of AFINA-te PROJECT STUDY (Physical Activity and Nutritional Information for Adolescents) a longitudinal study developed in the Porto area, Portugal, designed as an intervention project to promote nutritional knowledge and physical activity. Twenty-five public schools within the Porto area (Portugal) were invited by mail and email to participate in the study. From these, 13 schools declined to participate, 6 did not reply to our invitation and 6 schools agreed to take part in this study.

Respondents included 603 children and adolescents who agreed to participate and had parental written consent to take part in the study. After eliminating individuals who did not attend PE classes, the final sample comprised 472 youngsters (29.8%; 206 boys and 266 girls) aged between 10 and 18 years (mean: 14.43 ± 2.79).

Ethical approval for this study was obtained from the Faculty of Sports ethics committee, the Portuguese Foundation for the Science and Technology and by the regional section of the ministry of Education.

### Anthropometric measures

Body mass and height were evaluated in accordance with standard procedures. Weight was measured to the nearest 0.10 kg, with participants lightly dressed (underwear and t-shirt) using a portable digital scale (Tanita Inner Scan BC 532, Wembley, UK). Height was measured to the nearest 0.10 m in bare or stocking feet with children standing upright against a Holtain portable stadiometer (Tanita). Body Mass Index (BMI) was calculated from the children's height and

weight [weight (Kg)/height2(m)]. The classification of students' BMI was performed according to the internationally agreed procedures proposed by Cole (2000) considering the children's and adolescent's age and gender, in order to be classified as normal, overweight and obese. Thus, in our study children were categorized as non-obese group (NOW), and overweight/obese group (OW), according to the age and sex-adapted values (Cole, 2000).

**Physical Activity**

PA and MVPA during PE classes were measured using the Actigraphs accelerometers, model GTM1 and wGT3X-BT (Pensacola, FL, USA). For the purpose of this study, epoch duration or sampling period was set to 5s. The accelerometer was fixed on the students' waist from the beginning to the end of the PE class. After collecting, the data have been downloaded to the software Actilife where they were processed. Initially, wear/ use time was validated, checking that the device was used/ unused and differentiating time to sleep/physical activity according to the algorithm developed by Choi et al. (2011). Afterwards the data was filtered according to the schedule of PE classes attended. Finally data were analyzed in accordance with specific cut-off points (in counts per minute) developed by Evenson et al. (2008): sedentary activity - 0 to 100; Light - 101 to 2295; Moderate - 2296 to 4011; Vigorous - more than 4012. To study effects the MVPA was considered from 2296.

**Physical Education Classes**

The PE classes observed form part of the regular school curriculum defined by the Ministry of Education and Science and are carried out twice a week, by a specialized physical education teacher. To assess "normal" non-intervened PE, no instructions were given regarding the content of those lessons. The content of class was recorded because it is known that it can be determinant for the PA intensity.

We observed students' behavior into the two PE classes that they have during the week, for a total of 119 PE classes, 23 45PE classes and 96 90PE classes, and later the mean percentage of the PA developed was calculated. Each session of 45PE has a duration lasting 20 to 49 minutes (mean: 31.68±6.48) and 90PE has a class duration ranging 42 to 84 minutes (mean: 66.20±7.23). The PE class time record was set when at least 51% of the students were present and the class record was ended-up when at least 51% left the PE setting. This record was used to calculate the duration of each class. The measure of the outcome (mean proportion of class time spent in PA) was obtained by dividing the mean class time spent in PA by the mean total duration of the classes.

**Statistical Analysis**

A descriptive analysis (means and sd.'s) was calculated to describe young's characteristics. For data analysis, we have checked the normality of variables. The association between PA intensities and BMI were analyzed through a general linear model (GLM) - ANCOVA. Each model was adjusted for gender, age and modality practiced in the class, as these can be considered confounding variables. Initially, we tested the influence of all the variables and when some wasn't significant it was removed from the model. The comparisons between compliance with MVPA in PE classes' recommendations (more than 50% of class time in MVPA) according to the BMI were evaluated with one sample t-test. The comparisons between contributions of PE classes to the compliance of daily PA recommendations in accord to BMI (% of time that PE classes contribute for the compliance of 60 minutes of MVPA per day) were calculated using an Independent T-Test. A stepwise logistic regression analysis was performed to examine the association between MVPA in 45PE and 90PE classes and weight status.

All data were analyzed by statistical software SPSS® 20.0 for a significance level of 5%.

## Results

Table 1 shows descriptive of PA during PE classes by weight status. The prevalence of overweight/obese was 33.3%. OW were heavier, smaller and had a higher BMI than their NOW peers ($P<0.05$). Data show statistical significant differences between weight status categories in minutes of MVPA in 45PE and 90PE ($p<0.05$). NOW were significantly more engaged (36.73%) in MVPA during 45PE (10.62 min) than (28.72%) their OW (7.94 min) and the same occurs in 90PE, with NOW engaged in MVPA 31.4% of the total time (20.46 min) and NO 26.04% (17.09 min). Overall, participants did not meet the recommendation for 50% MVPA, either in 45PE or 90PE.

As shown in figure 1 the percentage of NOW that did not meet the recommendations in 45PE was 74%, while for OW was 87%. In 90PE classes 83% of NOW and 89.1% of the OW did not meet the recommendations, respectively. NOW have committed significantly more percentage of time ($p<0.05$) than WO in moderate PA in 45PE and 90PE (18.25% vs 18.51% and 18.25% vs 16.05%, respectively), vigorous PA in 90PE (13.18% vs 10.04%), MVPA in 45PE (36.73% vs 28.72%) and in 90PE classes (31.37% vs 26.04%). In contrast, OW spent more time than NOW in light PA in 90PE classes (54.25% vs 49.56%, $p<0.05$).

Table 2 shows that there are differences in the contribution that 45PE and 90PE classes gave for the compliance of daily MVPA recommendations. NOW group had higher contribution than OW ($p<0.05$). Interesting, 90PE contributes significantly more ($p<0.05$) for the daily MVPA recommendations compliance than 45PE did either in NOW (34% vs 18%) or OW (29% vs 13%).

Logistic regressions showed that OW were approximately three times more likely to not achieve the PE - MVPA recommendations than their NOW counterparts ($p\leq0.05$) in 45PE (Table 3). No statistical significant associations were found for 90PE classes.

## Discussion

This study examined the association between objectively PA intensity levels during 45PE and 90PE and weight status of Portuguese students. The relevance

of our study lies on the fact that little is known about how PA intensity during PE with different durations is associated with obesity in young and also the guidelines accomplishment for MVPA taking account weight status.

We found a prevalence of 33% of OW that are similar to those found in previous studies in Portuguese population (Rito, Paixão, Carvalho, & Ramos, 2012). The Portuguese Institute of Sport and Youth has conducted a study aiming analyze the fitness levels of Portuguese population and they found that 1 in 3 young (32.7%) have WO according to WHO classification (Baptista et al., 2011).

Our data suggest that differences in MVPA levels during 45PE and 90PE were associated with weight status being NOW engaged in more intense activities ($p<0.05$) than their OW counterparts [(45PE: 37% vs 29%, respectively; 90PE: 31% vs 26%)]. In addition, the percentage of the OW students that met the recommended guidelines in 45PE classes was around 13% and 11% in 90PE classes. These results are worth to discuss because it is expected that PE is a setting that provides high levels of PA and uses tools and strategies that lead them to adopt healthy lifestyles. Several studies have addressed the relationship between PA and obesity in activities and/or setting outside school PE. Moreover, our results also showed that OW were approximately three times more likely not to meet the ≥50% MVPA during 45PE classes than their NOW peers. Previous study focused on relationship between PA carried out during PE and weight status suggested that there was little evidence about the body mass being affecting the levels of PA during PE classes, because it is common OW youngsters commit them to track the movements performed by their peers with normal-weight (Stuart J. Fairclough & Gareth Stratton, 2006; Kremer et al., 2012). However, a recent study aiming to compare the objectively measured PA levels across PE, school playtime and extra-curricular sport in secondary school students found statistical differences between MVPA values reached during PE classes (NOW: 76.9 min; OW: 68.7 min) (Mayorga-Vega & Viciana, 2015), which are, however, much higher than those found in our study.

A reason for the differences in our outcomes may lie on the fact that in short lessons (45PE) teachers tend to make more games, which require a greater children's and adolescents' commitment, that may lead students with OW not to

follow their NOW peers. The lack of motivation, or simply not being as efficient as the performances of colleagues, may be associated with less effort in class (S. J. Fairclough & G. Stratton, 2005). In 90PE classes we observed a tendency to OW being the least likely to meet recommendations, but we have not found statistically significant differences between being OW and not meeting the recommendations for PE classes. This can be related to the lower intensity of the class, the use of more analytical exercises and transmission of information time carried out for a longer period of time. Longer lessons may promote longer bouts of management and transition time, both of which compromise learning results (Smith et al., 2015), allowing OW students to track their colleagues NOW. Stuart J. Fairclough and Gareth Stratton (2006) despite not having found statically differences in MVPA performed in PE classes between NOW and OW (37% vs 36%), a study conducted by  has reported that in comparison with NOW adolescents, OW might not be provided with optimal psychological experiences during PE classes because their presented values for enjoyment and perceived competence lowers than the NOW (Stuart J. Fairclough & Gareth Stratton, 2006).

A previously study (Cawley, Frisvold, & Meyerhoefer, 2013) realized with the objective to measure the causal effect of PE time on the weight of elementary schoolchildren found that PE lowers BMI z-score and reduces the probability of obesity among 5th graders, but this effect is concentrated among boys. This represents some of the first evidence of a causal effect of PE on youth obesity, and thus offers at least some support for the assumptions behind the Centers for Disease Control and other organizations that recommended the increasing of the amount of time that school children and adolescents spend in PE.

There are convincing evidences that PA takes many benefits to health and intervention programs can help to promoting healthy weight in children and adolescents, offering higher intensity levels, especially of MVPA (Mark & Janssen, 2011). Extracurricular programs seems to have even more relevance for WO young (Luísa Aires et al., 2015), once they need to improve their skills, their fitness levels and feel more effective on physical activities could take them to enjoy more the practice. An intervention study conducted by Mark and Janssen (2011) revealed an inverse relation between total, low, moderate and vigorous

intensity PA with total body and trunk fat assessed by DEXA. Other study (Sun et al., 2011), observed also a decrease in body fat, trunk fat and waist circumference, related to exercise compliance, but did not significantly decrease body weight and BMI. A metaanalysis conducted by (Guerra, Nobre, Silveira, & Taddei, 2013) suggested that, regardless of the potential benefits of PA to reduce participant's weight in school environments, the interventions did not have a statistically significant effect. However, it is difficult to generalize from these results because the duration, intensity and type of PA used in the interventions varied greatly.

In Portugal, a longitudinal intervention study has been conducted, focusing in young people with WO. The ACORDA Project is an 8-month multidisciplinary, school-based intervention program, aimed to change behaviors by providing easy access to PA (Luísa Aires et al., 2015). The intervention promote significant results: important cardiometabolic outcomes as fasting glucose, plasmatic total cholesterol and systolic blood pressure have decreased significantly. However, the favorable results for PA did not result in significant decreases in body fat or trunk fat, neither in BMI or waist circumference, that can be explained by the fact that the target group was not exclusively of OW children. Though, this study found that their intervention provided a significant increase in PA levels and reduced cardiovascular risk factors in school youngsters, highlighting the relevance of this type of intervention through promotion of PA and the positive effect on children and adolescents health, especially for WO.

The offer of extracurricular programs that contribute to the ability development, the exploration of PA in a more pleasurable way, without the pressure and competitiveness of more skilled colleagues, could be a great way to motivate WO and to provide them tools that lead to the adoption of more active lifestyles.

The large standard deviation found in our study suggests wide individual variations in MVPA and the importance of considering participants' intra-individual variability. Such variation in activity levels reflects the influence of contextual and pedagogical factors (such as: lesson objectives, content, environment, teaching styles …) (Bevans et al., 2010; McKenzie et al., 2000). This variability is particularly important bearing in mind that generally low levels

of MVPA are being committed in PE classes and so it is important to understand how we can help students to be more active in PE classes and, consequently, throughout their day. Our study shows an association with MVPA carried out in PE classes and weight status, suggesting that being OW is related to a lower activity in class, so it is important that we can reverse that bidirectional relation because it is not just less practice of PA that contributes to the weight increasing in young. Being OW also makes them less active and this creates a cycle of inactivity that it is difficult to fight.

So it is important to create PE programs more committed with health benefits, seeking to contribute more to high MVPA levels, because OW is an unfortunate reality and the sooner we join efforts to combat it more young people we can help to understand the importance that PA can have on their life and their well-being. It is also important to increase teacher's consciousness about the association between time spent in lesson contexts, promotion of PA, and student engagement in MVPA, which is essential for fitness development (Smith et al., 2015).

Some limitations of the study should also be recognized. The study included school young from a metropolitan area only, which makes difficult to generalize the findings. Further, it is not possible to infer causal relationships between PA levels in PE classes and overweight status with such a cross-sectional design. However, this study focuses on the assessment of PA levels using an objective measure, through the use of accelerometers, that enhances our findings.

## Conclusion

Our findings suggest that during PE classes youngsters spent a reduced amount of time engaged in MVPA, independently of their weight status. NOW and OW who meet the recommendations do it just above the reference value and those that do not meet the recommendations only reach half the recommended amount. Furthermore, NOW spent significantly more time engaged in MVPA than OW. In contrast, OW spends more time in LPA in 90PE classes than NOW. OW were approximately three times more likely to not meet the ≥50% MVPA in 45PE classes than their NOW counterparts.

These findings have important policy implications for physical education curriculum, emphasizing that it is fundamental that health stays at the center of the planning, because such a curriculum engaged in contributing for the increase of the MVPA levels, collaborating for a controlled weight status, could help PE to achieve their purposes, contributing to young people to be more active and healthier.

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**Table 1.** Descriptive statistics of study participants.

| | NOW (n=315) | WO (n=157) | P-value |
|---|---|---|---|
| Age (years) | 14.85±2.64 | 13.57±2.89 | **0.000** |
| Weight (Kg) | 52.26±11.70 | 64.79±15.67 | **0.000** |
| Height (cm) | 160.54±12.04 | 156.64±12.11 | **0.001** |
| BMI (Kg/m$^2$) | 20.01±2.39 | 26.03±3.34 | **0.000** |
| SB (minutes) | | | |
| *45 min. Classes* | 3.22±3.09 | 4.01±6.33 | 0.170[b] |
| *90 min. Classes* | 12.65±11.50 | 12.69±7.83 | 0.972[d] |
| LPA (minutes) | | | |
| *45 min. Classes* | 14.81±5.83 | 16.23±6.03 | 0.199[b] |
| *90 min. Classes* | 32.34±10.06 | 35.72±10.03 | **0.001**[e] |
| MPA (minutes) | | | |
| *45 min. Classes* | 6.58±3.96 | 4.99±2.74 | **0.026**[c] |
| *90 min. Classes* | 11.89±6.82 | 14.91±6.84 | 0.066[d] |
| VPA (minutes) | | | |
| *45 min. Classes* | 4.21±3.98 | 3.31±3.52 | 0.191 |
| *90 min. Classes* | 8.60±8.37 | 6.60±5.08 | **0.008**[e] |
| MVPA (minutes) | | | |
| *45 min. Classes* | 10.62±5.60 | 7.94±4.53 | **0.011**[c] |
| *90 min. Classes* | 20.46±11.42 | 17.09±9.37 | **0.001**[d] |
| Physical Activity Patterns (%) | | | |
| *SB* | | | |
| *45 min. Classes* | 10.55±9.09 | 13.70±9.71 | 0.085[b] |
| *90 min. Classes* | 19.00±16.15 | 19.05±11.48 | 0.974[d] |
| *LPA* | | | |
| *45 min. Classes* | 53.89±19.58 | 58.67±19.63 | 0.137 |
| *90 min. Classes* | 49.56±15.48 | 54.25±15.30 | **0.002**[e] |
| *MPA* | | | |
| *45 min. Classes* | 23.81±12.03 | 18.51±9.41 | **0.002**[b] |
| *90 min. Classes* | 18.25±10.30 | 16.05±9.98 | **0.026**[e] |
| *VPA* | | | |
| *45 min. Classes* | 14.99±12.09 | 11.00±10.04 | 0.083[b] |
| *90 min. Classes* | 13.18±12.05 | 10.04±8.05 | **0.005**[e] |
| *MVPA* | | | |
| *45 min. Classes* | 36.73±17.40 | 38.72±14.52 | **0.021**[c] |
| *90 min. Classes* | 31.37±17.34 | 26.04±14.02 | **0.001**[d] |

BMI: body mass index; SB: Sedentary Behavior; LPA: Light Physical Activity; MPA: Moderate Physical Activity; VPA: Vigorous Physical Activity; MVPA: Moderate and Vigorous Physical Activity. Data are expressed as means and standard deviations. Bold text indicates significant P values ($p<0.05$). [a] Adjusted values for age. [b] Adjusted values for modality practiced in the class. [c] Adjusted values for age and modality practiced in the class. [d] Adjusted values for gender and modality practiced in the class. [e] Adjusted values for gender, age and modality practiced in the class.

Table 2. Contribution that PE class gives to the compliance of daily MVPA recommendations (60 minutes of MVPA per day) according to BMI.

| | NOW | OW | P-value |
|---|---|---|---|
| MVPA (%) | | | |
| *45 min. Classes* | 17.70±9.50* | 13.23±7.81* | **0.011**[a] |
| *90 min. Classes* | 34.10±19.41 | 28.48±15.59 | **0.001**[b] |

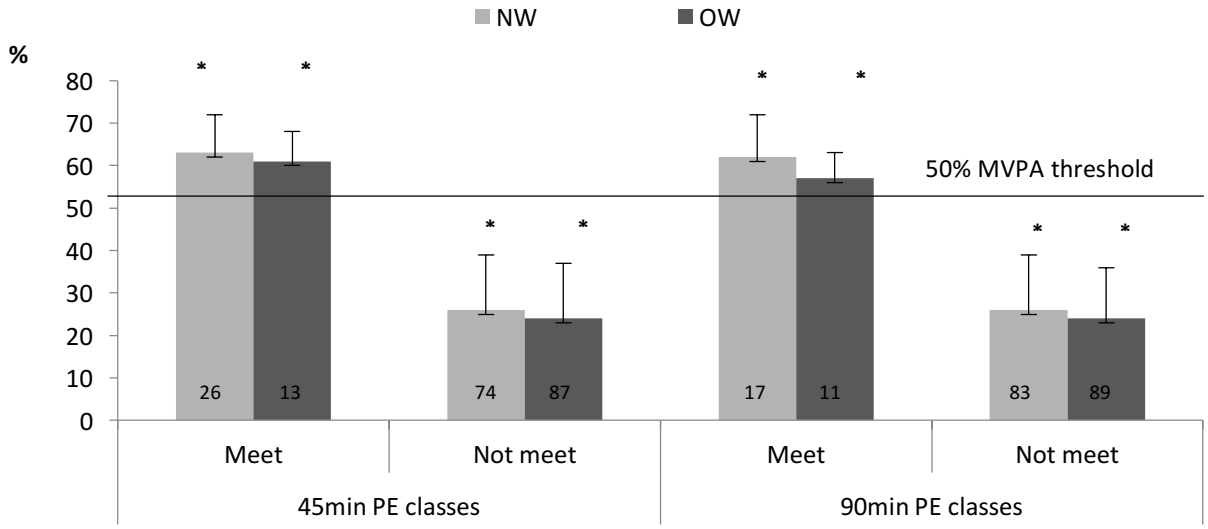
MVPA: Moderate and Vigorous Physical Activity. Data are expressed as means and standard deviations. Bold text indicates significant P values ($p<0.05$).[a] Adjusted values for age and modality practiced in the class. [b] Adjusted values for gender and modality practiced in the class.*Significant differences between 45 and 90 minutes PE classes in each BMI group.

Table 3. Logistic regressions showing the association between physical activity guidelines for physical education classes and obesity status.

| | OR | (95% CI) | P-value |
|---|---|---|---|
| No meet (≥50% MVP/ | | | |
| *45 min. Classes* | **2.5** | **(1.5-5.8)** | **0.04** |
| *90 min. Classes* | 1.8 | (0.9-3.0) | 0.09 |

MVPA: Moderate and Vigorous Physical Activity. Bold text indicates significant P values ($p<0.05$).

**Figure 1.** Compliance with MVPA recommendations for PE classes in 45 and 90 minutes PE lessons in NW and OW. *Significant differences between the mean percentage of MVPA in PE classes and the recommendations of 50% of the class time in MVPA. At the bottom of the column are the values of the percentage of participants who meets or does not meet the recommendations.



**PAPER III**

# Contribution of Physical Education Classes with different durations, for Daily Physical Activity

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**Abstract**

Objective: For many youngsters, physical education classes (PE) provides the most relevant opportunity to be engaged in physical activity (PA). Although the evidences suggested low levels of PA in PE few studies have focused their investigation on the contribution of PA performed during PE to daily PA. Therefore, the purpose of this study was to analyze differences between PA of Portuguese youngsters during daily school hours when they attended PE (PED) with 45 min of duration (PED45), PE with 90 min of duration (PED90), school days without PE (NPED) and weekend days (WD): Further we also aim to assess the relative contribution of PE classes, to daily PA.

Methods: This study was conducted in four Portuguese public schools with 441 students (188 boys and 253 girls) volunteers, aged between 10 to 18 years (14.31 ± 2.70). PA was assessed using an Actigraph accelerometer during 7 consecutive days. Data were analyzed with specific software and using age-specific counts-per-minute cut-off points. Independent and general linear model repeated measures were used to assess differences between PA according to NPED, PED45, PED90 and WD, taking into account gender and weight status (normal weight and overweight). A logistic regression was used to investigate the contribution of PE for the compliance of youngsters' daily PA recommendations.

Results: PED45 contribute, on average, 16.9% for the daily MVPA and PED90 accounted for 32.2%. All students engaged in more MVPA on PED than NPED or WD ($P<0.05$). Boys engaged more in MVPA than girls during all week ($P<0.05$) and no differences were found for weight status. PE classes were associated with higher odds to accomplished the recommended 60 min of daily MVPA (OR = 2.66, 95% CI = 2.01-3.53).

Conclusion: This study suggested that PE increased the daily MVPA levels and played a considerable role in providing PA to accomplish PA guidelines.

**Keyword:** Accelerometer, Physical Activity; Physical Education; Young.

## Introduction

Obesity is one of the most serious public health challenges of our century and it is a global problem that is enhancing at an alarming rate (World Health Organization, 2014). Furthermore, PA among youth has declined in recent decades (Yeung & Hills, 2007) and sedentary behavior seems to be increasingly present in young's lives (Mitchell et al., 2013).

An increasing number of studies have demonstrated the beneficial effect of PA on health (Ekelund et al., 2012; Lee & Paffenbarger, 2009). Given the fact that children and adolescents spend about half of their day in school, schools play an important role in providing and promoting PA (Kretschmann, 2014; Pate & O'Neill, 2008). For many youngsters, school offers the main opportunity for being physically active (R. Bailey, 2006; Expert Group on Health-enhancing physical activity, 2015) and this could be even more relevant for overweight youngsters, because they are generally less active than their normal weight counterparts (Cooper et al., 2015; Ekelund et al., 2004).

Within the school setting, PE has been seen as the most important way for the promotion of healthy and active lifestyles among young people (S. Fairclough & G. Stratton, 2005), providing meaningful, relevant and positive physical activity experiences that might possibility sustain those attitudes till adult life. Exposure to an adequate amount of PE class time during which physical activity is maximized increases students' energy expenditure, which is a key contributor to the maintenance of healthy weight and fitness (Cale & Harris, 2013).

However, PE programs face numerous challenges including pervasive inactivity among children and families (Nader et al., 2008) competing with academic priorities (R. R. Pate et al., 2006) and budget cuts (T.L. McKenzie & D. Kahan, 2008).

Schools are not being able to provide the frequency and intensity of PE and PA opportunities recommended (Sallis et al., 2012b). Healthy People 2010 prescribed an increase in adolescents' participation in daily PE (U.S. Department of Health and Human Services, 2000), with at least 50% of class time devoted to being physically active (Centers for Disease Control and Prevention, 2010). However, studies have shown that the majority of the schools does not meet the

recommendations or give their students adequate possibilities to participate in PA (Kahan & McKenzie, 2016).

Nevertheless, PA levels during PE have been shown to be low (Stuart J. Fairclough & Gareth. Stratton, 2006), with a percentage of time spent in moderate to vigorous physical activity (MVPA) only about one third of total PE time, the contribution of PE might still be substantial. For many young people may represent the only opportunity to perform significant MVPA. So, the objective of this study was to assess PA during PE classes and to determine their contribution for the daily PA. Furthermore, we also aim to analyze differences between PA of Portuguese youngsters during daily school hours when they attended PE (PED) with 45 min of duration (PED45), PE with 90 min of duration (PED90), school days without PE (NPED) and weekend days (WD).

## Material and Methods

*Participants and data collection*

This was a cross-sectional study conducted in basic and secondary schools as a part of AFINA-te PROJECT STUDY (Physical Activity and Nutritional Information for Adolescents) a longitudinal study being developed in Porto area, Portugal, designed as an intervention project to promote nutritional knowledge and physical activity. Ethical approval for this study was obtained from the Faculty of Sports ethics committee, the Portuguese Foundation for the Science and Technology, Portuguese Data Protection Authority (Process 6766/2015) and by the regional section of the ministry of Education (Process 1402/2015).

Twenty-five public schools within the Porto area (Portugal) were invited by mail and email to participate in the study. From these, 13 schools declined to participate, 6 did not reply to our invitation and 6 schools agreed to take part in this study.

Respondents included 603 children and adolescents that agreed to participate and had parental written consent to take part in the study. After eliminating individuals who did not attend PE classes and did not use an accelerometer at least 4 consecutive days (3 days of weekday and 1 day of

weekend) the final sample comprised 441 youngsters (253 girls) aged between 10 and 18 years (mean: 14.31 ± 2.70).

Anthropometric measures

Body mass and height were evaluated in accordance with standard procedures. Weight was measured to the nearest 0.10 kg, with participants lightly dressed (underwear and t-shirt) using a portable digital scale (Tanita Inner Scan BC 532, Wembley, UK). Height was measured to the nearest 0.01 m in bare or stocking feet with children standing upright against a SECA 217 portable stadiometer. Body Mass Index (BMI) was calculated from the children's height and weight [weight (Kg)/height$^2$(m)]. The classification of students' BMI was performed according to the internationally agreed procedures proposed by Cole (2000), considering the children's and adolescent's age and gender, in order to be classified as normal, overweight and obese. Thus, in our study children were categorized as non-obese group (NOW), and overweight/obese group (OW), according to the age and sex-adapted values (Cole, 2000).

Physical Activity

PA was measured using Actigraphs accelerometers, model GTM1 and wGT3X-BT (Pensacola, FL, USA). The accelerometer was placed on the right side of the waist, and participants were instructed to use it all day, over 7 consecutive days. After collecting, the data has been downloaded to the Actilife software where they were processed. Initially, wear time use was validated, checking that the device was used/ unused and differentiating time to sleep/physical activity according to the algorithm developed by Choi et al. (2011). A minimum recording of 480 minutes per day was established to accept the data as a valid daily PA, and the 7 evaluated days having at least 4 days of valid use. A minimum of 4 measurement days has been recommended to reach a sufficient reliability, i.e., an intraclass correlation coefficient (ICC) of 0.8 among days (Trost, Pate, Freedson, Sallis, & Taylor, 2000b). To evaluate the PA performed on PE the data was filtered according to the schedule of PE classes attended.

Data were analyzed in accordance with specific cut-off points (in counts per minute) developed by Evenson et al. (2008) considering the following

intervals to determine the time spent in PA at different intensities: Sedentary behavior - 0 to 100; Light - 101 to 2295; Moderate - 2296 to 4011; Vigorous - more than 4012. For study purposes the MVPA was considered from 2296.

Physical Education Classes

The PE classes observed form part of the regular school curriculum defined by the Ministry of Education and Science, and are carried out twice a week, by a specialized physical education teacher. To assess “normal” non-intervened PE, no instructions were given regarding the content of those lessons. The content of class was recorded because it is known that it can be determinant for the PA intensity.

We observed students’ behavior in the two PE classes that they have during the week, for a total of 119 PE classes, and later the mean percentage of the PA developed was calculated. Each session of 45PE has a duration lasting 20 to 49 minutes (mean: 31.68±6.48) and 90PE has a class duration ranging 42 to 84 minutes (mean: 66.20±7.23). The PE class time record was set when at least 51% of the students were present and the class record was ended-up when at least 51% left the PE setting. This record was used to calculate the duration of each class. The measure of the outcome (mean proportion of class time spent in PA) was obtained by dividing the mean class time spent in PA by the mean total duration of the classes.

*Statistical Analysis*

A descriptive analysis (means and sd.’s) was calculated to describe young’s characteristics. All data were analyzed by statistical software SPSS® 20.0 for a significance level of 5%.

To examine the patterns of PA participation, data from the school time were divided into four groups: NPED, PED45, PED90 and WD. Gender, age and BMI differences between PA intensities performed throughout the week and the contribution that 45 and 90 minutes PE class gives for daily MVPA were analyzed with One-way repeated measures ANOVA. Post-hoc pairwise comparisons were

tested using the Bonferroni correction for multiple comparisons to determine which PA level and day of the week differ from each other.

Regression analyses models were conducted to establish association between compliance of daily 60 minutes of MVPA recommended and having PE. Known potential confounders for the MVPA performed by youngsters, namely, gender, age and BMI were included in the analyses to find the model that best fits the observed data.

**Results**

Participants' characteristics and PA patterns throughout the week of all the participants are summarized in Table 1.

No statistical significant differences were found for gender, age and BMI. On average, children and adolescents had 6.2±1.0 days with valid accelerometer data including 1.6±0.5 weekend days and 1.7±0.4 days with PE. 45PE has mean class duration of 32±6 minutes and 90PE has mean duration of 66±7 minutes (Figure 1).

Using One-way repeated measures ANOVA, we found statistically significant differences between days of MVPA performed throughout the week ($p<0.05$). Mauchly's test indicated that the assumption of the sphericity has been violated $\chi2(5) = 18.75$ $p = 0.002$, therefore degrees of freedom were corrected using Huynh-Feldt estimates of sphericity ($\varepsilon = 0.95$). The results show that there was a significant effect of each days of the week to achieve more MVPA, $F (2.84) = 2.98$, $p = 0.034$. These results suggest that PED90 and PED45 had a significantly higher mean of MVPA than NPED [M diff = 20.76 (95%CI = 7.27 to 34.26) and M diff = 19.71 (95%CI = 9.09 to 30.33), $p < 0.05$] and WD [M diff = 33.36 (95%CI = 22.06 to 44.67) and M diff = 32.32 (95%CI = 21.57 to 43.07), $p < 0.05$]. No differences were found for PED45 and PED90 [M diff = 1.05 (95%CI = -8.75 to 10.85), $p < 0.05$].

No statistical differences were found between the Total Physical Activity (TPA), Sedentary Behavior (SB) and Light Physical Activity (LPA) performed all over the week, on PED45, PED90, NPED and WD [$F (2.56) = 0.33$, $p = 0.768$; $F (2.22) = 1.41$, $p = 0.247$; $F (2.91) = 0.31$, $p = 0.815$, respectively]. However, TPA

was higher in PED90 and PED45 when compared to the NPED [M diff= 30.61 (95%CI = -4.22 to 66.63 and M diff= 26.28 (95%CI = -4.17 to 76.73), $p < 0.05$], and WD [M diff = 109.49 (95%CI = 56.07 to 162.91) and M diff= 105.16 (95%CI = 58.73 to 151.59, $p < 0.05$]. Furthermore, our results suggest that SB was higher in NPED than in PED90 [M diff = 15.01 (95%CI = -13.30 to 43.31), $p < 0.05$], PED45 [M diff = 35.05 (95%CI = 11.94 to 58.15), $p < 0.05$] and WD [M diff= 80.85 (95%CI = 41.12 to 120.58), $p < 0.05$]. Regarding LPA, on average, PED45 has higher amount of time than NPED [M diff = 41.61 (95%CI = 20.93 to 62.29), $p < 0.05$] and WD [M diff = 27.04 (95%CI = 0.43 to 53.65), $p < 0.05$]. Despite not founding statistically significant differences, LPA in PED45 is higher than in PED90 [M diff = 7.44 (95%CI = -15.49 to 30.36), $p > 0.05$].

On average, we found differences in the contribution that PE, with different durations, gives to daily MVPA, $F(1) = 71.73$, $p = 0.000$. Thus, PE classes contribute 16.8% for MVPA in PED45 and 34.7% for MVPA in PED90, corresponding to 9 min and 19 min of MVPA, respectively.

Our results also suggest that on PED45 and PED90 higher number of youngsters complies with the 60 minutes of daily MVPA recommended (47.8% and 50.2%, respectively) and in NPED and WD the compliance is much lower (27.7% and 12.7%, respectively). A logistic regression was performed to examine the effects of having PE classes, adjusted for gender, age and BMI, on the compliance of recommend 60 minutes of daily MVPA (Table 2). The logistic regression model was statistically significant $\chi 2(5) = 144.516$ $p = 0.000$. The model explained 18.6% (Nagelkerke $R^2$) of variance in the compliance of MVPA recommendations and correctly classified 69.0% of cases. PED45 and PED90 had, respectively, 3.18 and 2.90 times higher odds to comply with international MVPA recommendations. Boys are 3.69 times more probable to comply with the 60 minutes of daily MVPA than girls and older participants are 1.07 more likely to accomplish the recommendations than their younger counterparts. No differences were found for BMI.

## Discussion

This study reports information about the engagement in PA, comparing PED, NPED and WD and analyze the contribution that PE gives for daily MVPA. Our results suggested that PE effectively increases daily MVPA levels, with youngsters engaged significantly more time in MVPA in PED than during all others days of the week ($P < 0.05$) (see figure 1). This represents an improved MVPA participation of 16.9% in PED45 and 32.2% in PED90. Furthermore, PE contributed considerably to overall daily PA. On PED45 participants performed 26 min more of TPA than on NPED and on PED90 they accumulated 30 min more, with PED45 contributing 10 min for daily MVPA and PED90 19 min.

Few studies have focused its attention on the PE class contribution to health-related daily PA recommendations and such data are valuable for the designing of interventions to increase PA as well as for properly prescription of individual exercise as described in other specific groups (Cooper, Page, Fox, & Misson, 2000; S. Vale, R. Santos, L. Soares-Miranda, P. Silva, & J. Mota, 2011). The guidelines for children and adolescents PA suggested 60 minutes of daily MVPA to have benefits for health (Strong et al., 2005; World Health Organization, 2010). This is even more relevant, nowadays, attending that inactivity and low levels of PA are important contributor factors to the youngsters obesity (Hu, 2003; Marshall et al., 2004) and recent data showed high levels of obesity in earlier ages (Antunes & Moreira, 2011; Baptista et al., 2011). So, PE can play an important role for the promotion of PA, contributing for the public health (Smith et al., 2015).

Studies carried out with the aim of analyzing MVPA on PE classes have shown low levels of engagement of students. Stuart J. Fairclough and Gareth. Stratton (2006) reviewed 44 articles to estimate the PA levels during PE classes and concluded that, on average, children and adolescents spend 37% of their PE time in MVPA. More recent data suggested that MVPA on PE classes it is even lower (Meyer et al., 2013; Nettlefold et al., 2011). However, during childhood and youth, PE provides an excellent opportunity to learn and practice skills likely to enhance lifelong fitness and good health (European Commission/EACEA/Eurydice, 2013). PE is not limited to training in physical

skills and has more than just a recreational dimension. Goals that extend beyond PE and sport, such as good health, sound personal development, and social inclusion, give further weight to the importance of including this subject in the school curriculum. PE have a societal value and in its White Paper on Sport (European Commission, 2007), the Commission pointed out that time spent in school PE could result in substantial education and health benefits.

The European Union Guidelines on Physical Activity (EU Working Group 'Sport & Health', 2008), supported by several studies (David Martinez-Gomez et al., 2009; M. S. Tremblay et al., 2011), highlight that the decline in PA levels among European youth and the increased sedentary lifestyles and obesity represent an enormous risk, which is responsible for several physical, metabolic and mental comorbidities, during youth and later life. The EU Guidelines on 'Health Enhancing Physical Activity' (EU Working Group 'Sport & Health', 2008) estimated that up to 80% of school-age youngsters engage in PA solely at school. So, sufficient time devoted to sport and PA at school, especially on PE classes, can make a key contribution to healthier lifestyles.

More recently, an Expert panel on integrated guidelines for cardiovascular health and risk reduction in children and adolescents (U.S. Department of Health and Human Services, 2012) reviewed a considerable number of studies that allowed them to collect information about the relation between PA and cardiovascular diseases. They found strong evidence that increases in MVPA are associated with lower systolic and diastolic blood pressure, decreased measures of body fat, decreased BMI, improved fitness measures, lower total cholesterol, lower LDL cholesterol, lower triglycerides, higher HDL cholesterol and decreased insulin resistance in childhood and adolescence. There is less specific information on the type and amount of PA required for optimum cardiovascular health, however, reported PA interventions ranged from 20-60 minutes 2 to 5 times/week in children ages 3-17 years and included a wide variety of dynamic and isometric exercises that could prevent clustering of cardiovascular disease risk factors in younth. Inducing from these interventions that occurred in supervised settings to the real world of youth, the Expert Panel recommends at least 60 min of MVPA every day of the week for children over 5 years of age.

They suggested that there is strong evidence that PA should be promoted in schools. Therefore, increasing daily MVPA from 49 min on NPED to 69 min on PED90 and 68 on PED45 could have a crucial contribution to achieve the recommendations and, thus, to reduce the metabolic disease risk. Moreover, we found that on PED45 and PED90, 47.8% and 50.2%, respectively, of young students complies with the 60 minutes of daily MVPA recommended and PED45 and PED90 had, respectively, 3.18 and 2.90 times higher odds to comply with international MVPA recommendation. In NPED and WD the compliance it is much lower, 27.7% and 12.7%, respectively. T. A. Brusseau, Kulinna, Tudor-Locke, van der Mars, and Darst (2011), in a study conducted with 363 children (8-11 years old) using pedometers 7 consecutive days, found that children and youth were more active during school days than on weekend days and on PED comparing with NPED. More recently, Gråstén et al. (2015) in a study that analyzed objectively PA participation, with accelerometers, found that the two PE45 classes that students have on their week provide 26.2% and 33.6% of weekly MVPA of girls and boys, respectively. This concerning findings highlight the relevance of PE for the compliance of MVPA recommendations for young people and, consequently, to their health. From a Public Health perspective, PE has a crucial contribution for TPA and for daily MVPA (Meyer et al., 2013) and in a PA intervention study, Kriemler et al. (2010) showed that increased MVPA daily participation improved fitness and reduced cardiovascular risk. Therefore, the expansion of PE across more school days may also serve to increase children's PA during the school week (T. A. Brusseau et al., 2011). Our results support the Expert Group on Health-enhancing physical activity (2015), that on their recommendations encourage PE in schools, including motor skills in early childhood, and to create valuable interactions with the sport sector, local authorities and the private sector, suggested that the minimum PE taught time recommended during compulsory education period should be increased to at least 5 lessons per week, approximately 5 hours. The PE curricular structure and goals should be adjusted accordingly, defining tangible and flexible outcomes for each developmental stage, and suggesting the inclusion of realistic activities.

Some limitations of the study should be recognized. The study included youngsters from one metropolitan area only, which makes it difficult to generalize these findings. Additionally, it is not possible to infer causal relationships with cross-sectional design. Nevertheless, this study focuses on the assessment of TPA and MVPA levels using an objective measure with a high compliance rate during school hours. The content of the PE lesson might considerably influence the extent of MVPA in PE, while none of the teacher knew about the specific assessment of the PE lessons we cannot completely rule out a bias towards more active PE lessons while the accelerometer was worn. To minimize this bias we adjusted our data to the content of the class.

**Conclusion:**

The results of this study suggested that PE increased daily TPA and MVPA levels in young and played a considerable role in providing structured PA at these ages.

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Table 1. Participants' characteristics.

| | All (n = 441) |
|---|---|
| Age (years) | 14.31±2.70 |
| BMI (Kg/m2) | 22.04±3.96 |
| TPA | |
| PED45 (min/d) | 857.30±126.33 |
| PED90 (min/d) | 861.63±153.29 |
| NPED (min/d) | 831.03±117.85 |
| WD (min/ d) | 752.14±142.38 |
| SB | |
| PED45 (min/d) | 460.38±121.55 |
| PED90 (min/d) | 480.42±146.93 |
| NPED (min/d) | 495.42±110.74 |
| WD (min/ d) | 414.57±129.00 |
| LPA | |
| PED45 (min/d) | 328.64±89.63 |
| PED90 (min/d) | 321.20±87.90 |
| NPED (min/d) | 287.03±68.65 |
| WD (min/ d) | 301.60±96.03 |
| *MVPA* | |
| PED45 (min/d) | 68.28±58.38[a] |
| PED90 (min/d) | 69.33±67.88[a] |
| NPED (min/d) | 48.57±30.41[a] |
| WD (min/ d) | 35.97±52.59[a] |

Data are expressed as means and standard deviations.

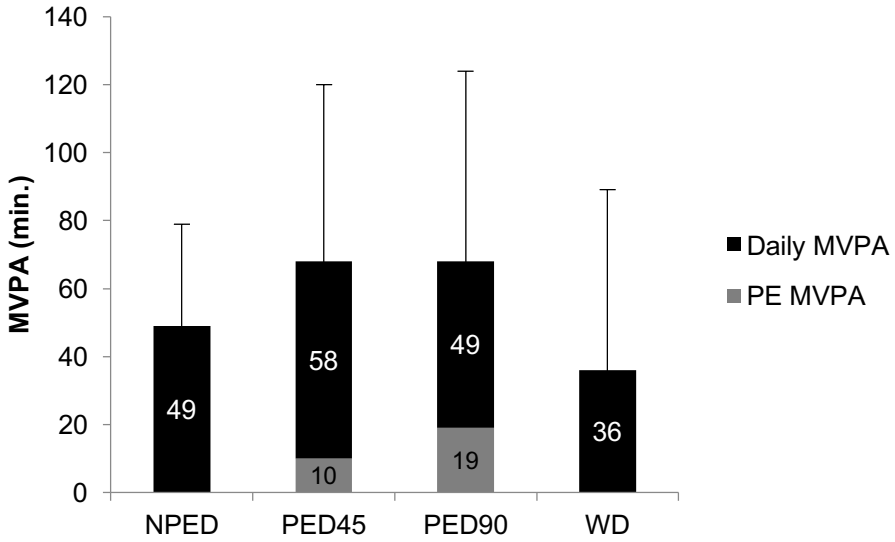
BMI: Body mass index; TPA: total physical activity; SB: sedentary behavior; LPA: light physical activity; MVPA: moderate to vigorous physical activity; PED45: 45 minutes physical education class days; PED90: 90 minutes physical education class days; NPED: days without physical education classes; WD: weekend days. a Values adjusted for gender, age and IMC. Bold text indicates significant P values ($p<0.05$).

Table 2. Logistic regressions showing the association between compliance of the 60 minutes daily of MVPA recommended and have PE.

| | OR | (95% CI) | *P* |
|---|---|---|---|
| PED45 | 3.18 | (2.03-4.98) | 0.000 |
| PED90 | 2.90 | (2.14-3.92) | 0.000 |
| Gender | 3.69 | (2.78-4.88) | 0.000 |
| Age | 1.07 | (1.01-1.13) | 0.016 |
| BMI | 0.83 | (0.62-1.12) | 0.233 |

PED45: 45 minutes physical education class days; PED90: 90 minutes physical education class days; BMI: body mass index. Bold text indicates significant P values (p<0.05).

**Figure 1.** Minutes spent in MVPA on NPED, PED45, PED90 and WD adjusted for gender, age and BMI and PE classes' contribution for MVPA in the PED.




Significant differences (P < 0.05) between days of the week.

| | NPED | PED45 | PED90 | WD |
|---|---|---|---|---|
| NPED | | **0.000** | **0.000** | **0.020** |
| PED45 | **0.000** | | 1.000 | **0.000** |
| PED90 | **0.000** | 1.000 | | **0.000** |
| WD | **0.020** | **0.000** | **0.000** | |

# CHAPTER IV – OVERALL DISCUSSION

The European Union Guidelines on Physical Activity (EU Working Group 'Sport & Health', 2008), supported by several studies (David Martinez-Gomez et al., 2009; M. S. Tremblay et al., 2011), highlight that the decline in PA levels among European youth and the increased sedentary lifestyles and obesity represent an enormous risk, which is responsible for several physical, metabolic and mental comorbidities, during youth and later life. There is less specific information on the type and amount of PA required for health benefits. However, reported PA interventions allowed induce from these interventions, that occurred in supervised settings, to the real world of youth, the recommendation of at least 60 min of MVPA every day of the week for children over 5 years of age (U.S. Department of Health and Human Services, 2012). The estimative of that up to 80% of school-age youngsters engage in PA solely at school, clarified the relevance that sufficient time devoted to sport and PA at school, especially on PE classes, can make on contribution to healthier lifestyles (EU Working Group 'Sport & Health', 2008). So, with the present study we intend to compare the PA levels in physical education classes of children and adolescents, according to gender and weight status, and to analyze the meaning of the contribution of PE classes to physical activity weekly.

The division of the week in 3 moments (days with PE classes, days without PE classes and weekends) had the purpose of finding results that examined the relevance of the PE discipline on the life of children and adolescents.

Reduced number of studies focused their attention on the evaluation of PA patterns during PE classes, and those that mostly do, use cardiac frequency monitoring as a method of assessment of PA, thus making unfeasible an exhaustive and direct comparison with our results. With the use of the accelerometer, we intended to characterize the PA of students during PE of 45 and 90 minutes, and to analyze the values found according to gender and body composition of students.

We also intended to verify if the values found for MVPA reach the values recommended for PE and the contribution of these classes for the daily 60 minutes of MVPA recommended for the age range of the sample.

*Physical Activity*

The recommendation of more and better PA adjusted to individual needs and potential is nowadays an important goal in the education of all young, contributing decisively to a healthy existence. In general, sedentary is a public health problem (Bevans et al., 2010; Mitchell et al., 2013), which is a primary risk factor for the development of an extended set of diseases such as diabetes type 2, osteoporosis, arthritis, certain types of cancer and obesity (Janssen & Leblanc, 2010; Ortega et al., 2013) and is one of the 10 leading causes of death and disability (Hu, 2003; Pedersen, 2006; Warburton, Nicol, & Bredin, 2006).

Studies carried out with the aim of analyzing MVPA on PE classes have shown low levels of engagement of students. Stuart J. Fairclough and Gareth. Stratton (2006) reviewed 44 articles to estimate the PA levels during PE classes and concluded that, on average, children and adolescents spend 37% of their PE time in MVPA. More recent data suggested that MVPA on PE classes it is even lower (Meyer et al., 2013; Nettlefold et al., 2011). Sometimes the strong and consistent desire of young people to be active is often constrained by external factors such as educational policy and school curricula, rules related to safety and convenience imposed by parents, and environmental factors (Norton, Dollman, & Norton, 2005). Even thought, it is undeniable that, during childhood and youth, PE provides excellent opportunity to learn and practice skills likely to enhance lifelong fitness and good health (European Commission/EACEA/Eurydice, 2013). In this sense, the study and debate of children's and adolescents' PA habits becomes crucial.

Our results showed a total of 6.2±1.0 days with valid accelerometer data including 1.6±0.5 weekend days and 1.7±0.4 days with PE, and 5176.93±497.75 minutes of PA performed per week (821.35±97.61 per day). The MVPA achieved for our sample during the week was 336.13±29.90 (55.23±51.33 per day). On days with 45 minutes physical education classes (PED45) and days with 90 minutes physical education classes (PED90) young performed 857.30±126.33 minutes and 861.63±153.29 of TPA per day, respectively. On NPED and WD the TPA were lower, with values around 831.03±117.85 and 752.14±142.38 minutes of TPA per day, respectively. Regarding to MVPA, on PED45 and PED90 young

performed 68.28±58.38 and 69.33±67.88, respectively. The MVPA accumulated on NPED and WD were significantly lower than the previous one, prowling 48.57±30.41 and 35.97±52.59, respectively.

*PA performed through the week: PED, NPED, WD*

Few studies have focused its attention on the PE class contribution to health-related daily PA recommendations and such data are valuable for the designing of interventions to increase PA. The guidelines for children and adolescents PA suggested 60 minutes of daily MVPA to have benefits for health (Strong et al., 2005; World Health Organization, 2010). This is even more relevant, nowadays, attending that inactivity and low levels of PA are important contributor factors to the youngsters obesity (Hu, 2003; Marshall et al., 2004) and recent data showed high levels of obesity in earlier ages (Antunes & Moreira, 2011; Baptista et al., 2011). So, PE can play an important role for the promotion of PA, contributing for the public health (Smith et al., 2015). In this sense, with this study we intended to report information about the engagement in PA, comparing PED, NPED and WD and analyze the real contribution that PE gives for daily MVPA.

We found statistically significant differences between days of MVPA performed throughout the week ($p<0.05$) and these results suggested that PED90 and PED45 had a significantly higher mean of MVPA than NPED and WD.

Even though we did not find statistical differences, our data suggested that participants accumulated more SB on NPED than in PED90, PED45 and WD and inversely, TPA was higher in PED90 and PED45 when compared to the NPED and WD.

Regarding LPA, on average, PED45 has higher amount of time than NPED and WD. Despite not founding statistically significant differences, LPA in PED45 is higher than in PED90.

*Physical Activity on Physical Education Classes: Real Class Time*

In most basics and secondary schools, in 45PE and 90PE students have 5 minutes to equip before the class and 10 minutes to shower after class. This situation already affects the time available for the practice, that corresponds, approximately, in 45PE to 33.3% of total class time, and in 90PE 16.7% is spent in the bathing resort.

Several studies concluded that 31% of the 45PE class was used to equip and shower (McKenzie et al., 2000). Also, a study from Portugal (Wang et al., 2005) indicates that between 32% and 36% (90 min vs. 45 min) class time is used to equip and bathing and a more recently published study (Smith et al., 2014) confirms that 35% of class time is spent in the bathing resort.

Therefore, in our approach we used the real class time and to calculate the duration of each class the register was set when at least 51% of the students were present and the class evaluation was ended-up when at least 51% left the PE setting. Each session of 45PE has a mean duration of 32 minutes and 90PE has a mean duration of 66 minutes. Changing clothes, bathing and students' displacement to the PE class performing space can explain the difference between the time available and the real class time, corresponding at 29.5% in 45PE and 27.1% in PED90.

*Physical Activity on Physical Education Classes with different duration (45PE vs 90PE)*

Our results showed that children and adolescents spent 10.19±6.21 minutes in MVPA during 45PE and in 90PE it was 20.00±11.87 min., corresponding to 32.2% and 30.35% of the total time for 45PE and 90PE, respectively. Additionally, we do not found statistic difference in the PA realized in PE classes with different durations (45PE and 90PE; $p>0.05$), except for SB which is higher ($p<0.05$) in 90PE than in 45PE (17% of total class time and 11%, respectively). When we compare our results with the data founded in previous studies, this proportion is lower than the percentages of 46.8% (S. J. Fairclough & G. Stratton, 2005) and 43.5% (Lonsdale et al., 2013) reported by accelerometry

in same studies. However, other recent studies have found similar results to ours with percentages of 28.18% (Ferreira et al., 2014), 32.7% (Kremer et al., 2012), 32.8% (McKenzie et al., 2006) and 37.9% (Susana Vale et al., 2011) of MVPA in PE classes.

In a recent study accomplished in Portugal (Ribeiro, 2014), and in a study conducted in California (Smith et al., 2015), authors suggested that more total class time does not necessarily correspond to more time spent being active, in MVPA. Smith et al. (2015), pointed teacher characteristics and lesson-level pedagogical factors largely controlled by the teacher including the percentage of time spent changing clothes at the start and end of class, how time was spent in lesson contexts, teacher promotion of PA, and lesson location with possible explanation of the variability of PA realized in PE classes with different lengths.

The major of these factors were associated with teacher classroom management. So, it seems to be important to increase teacher awareness about the association between time spent in lesson contexts, promotion of PA, and student engagement in MVPA, which is essential for fitness development (Lonsdale et al., 2013). In a Germany sample, (Kobel et al., 2015), have conducted an investigation whether children accumulate more time in MVPA during multiple single PE lessons compared with double periods of PE, showing similar results to ours, suggesting that with regards to accumulation of MVPA during PE children benefit more from single lessons of PE than from double periods. The literature does not offer, at this time, an explanation for these conclusions, but children and adolescents seem to do more intense PA in the limited time of 45PE classes, taking advantage of the lower class time to be more physically active, than in the 90PE classes.

*Physical Activity on Physical Education Classes with different duration (45PE vs 90PE) by gender*

In our study, we intend to fully characterize the PA during PE class and therefore its relationship with gender. Therefore, our results suggest that boys were more active and participative in PE lessons than girls, engaging in more

MVPA in 45 and 90 PE classes ($P < 0.05$). Simultaneously, girls spent more time in SB and LPA during the class period than boys. Others studies have shown that boys are more active than girls in PE classes (Ferreira et al., 2014; Susana Vale et al., 2011). Studies carried out in Portugal (Almeida, 2011; Ribeiro, 2014) comparing the PA accomplished in classes with different duration (45 and 90 minutes) have found similar results to ours and a recently survey performed with the objective to characterize nutritional and PA habits of Portuguese population, suggested that boys are more active than girls in all ages, specially 5-14 years and 15-21 years old (IAN-AF 2015-2016).

When we analyze the compliance with international MVPA recommendations we found that 26% of boys meet the recommendations for MVPA in 45PE, with a mean percentage of class time in MVPA around 62.9%. In 90PE classes only 28% of boys meet the recommendation, with 61.3% of mean percentage of MVPA. Regarding girls, the percentage that meets the recommendations in 45PE is 15%, with 61.6% of mean percentage of MVPA. In 90PE classes, only 5% of girls meet the recommendation, with 61.3% of mean percentage of MVPA.

On average, boys were significantly more engaged ($p<0.05$) in MVPA than girls during both 45PE (11.78 min vs 8.97 min) and 90PE (25.69 min vs 15.63 min). Furthermore, our results suggested that boys are 3.69 times more probable to comply with the 60 minutes of daily MVPA than girls. In contrast, girls spent more time than boys in SB (13.14 min vs 9.93 min, $p<0.05$) and LPA in 90PE (36.83 min vs 30.84 min, $p<0.05$).

Some factors may be influencing this MVPA difference between the genders, including the kind of content covered, biological and motivational differences between genders, the expectations created by society and by their peers (S. Fairclough, 2003). PA is what makes PE classes different from the others school subjects. Maybe some PE activities do not encourage girls to engage in the same way that boys do. Some studies suggest that girls may not like to exercise themselves intensely during PE classes (McKenzie et al., 2006), perhaps because they are less motivated than boys (S. Fairclough, 2003). It is important to consider if we want PE lessons to be able to engage and captivate

students and contribute for them to be physically active. There is evidence that environmental factors, such as class size, location and class contexts influence the activity of young people and that there are clear policy implications for the PE class organization, which emphasize the need to create strategies to maximize MVPA participation (Skala et al., 2012).

*Physical Activity on Physical Education Classes with different duration (45PE vs 90PE) by weight status*

There are convincing evidences that PA takes many benefits to health and intervention programs can help promoting healthy weight in children and adolescents, offering higher intensity levels, especially of MVPA (Janssen & Leblanc, 2010). One of the most important relevance of our study relies on the fact that little is known about how PA intensity in PE classes with different durations is associated with obesity in youngsters and also the guidelines accomplishment for MVPA taking account weight status.

The prevalence estimates of overweight/obesity found in this Portuguese sample was 33.3% (32.3% in girls and 34.5% in boys). Our data showed similar values to those suggested in other studies among Portuguese population, also characterized by high levels of overweight and obesity (Rito et al., 2012). Comparing by gender, we verified that boys presented a higher prevalence of overweight than girls, 34.5% and 32.3%, respectively.

Focusing on PA levels, our data suggest that differences in MVPA levels during 45PE and 90PE were associated with weight status, being NOW engaged in more intense activities ($p<0.05$) than their OW counterparts [(45PE: 36.73% vs 28.72%, respectively; 90PE: 31.37% vs 26.04%)]. NOW were significantly more engaged in MVPA during 45PE (10.62 min) than their OW (7.94 min) and the same occurs in 90PE, with NOW engaged in MVPA 20.46 min and OW 17.09 min. In contrast, OW spent more time than NOW in LPA in 90PE classes (54.25% vs 49.56%, $p<0.05$).

Previous studies focused on relationship between PA carried out during PE and weight status suggested that there was little evidence about the body

mass affecting the levels of PA during PE classes, because it is common OW youngsters to commit themselves to track the movements performed by their peers with normal-weight (Stuart J. Fairclough & Gareth Stratton, 2006; Kremer et al., 2012). However, a recent study aiming at comparing the objectively measured PA levels across PE, school playtime and extra-curricular sport in secondary school students, found statistical differences between MVPA values reached during PE classes (NOW: 76.9 min; OW: 68.7 min) (Viciana et al., 2015a), which are, however, much higher than those found in our study.

The percentage of NOW that did not meet the recommendations in 45PE was 74%, while for OW was 87% and in 90PE classes, we found that 83% of NOW and 89% of the OW did not meet the recommendations, respectively. These results are worth to discuss because it is expected that PE is a setting that provides high levels of PA and uses tools and strategies that lead them to adopt healthy lifestyles.

Additionally, our results also showed that OW were approximately three times more likely not to meet the >50% MVPA their NOW peers, in 45PE, so it is important that we can reverse that bidirectional relation because it is not just less practice of PA that contributes to the weight increasing in young. Being OW also makes them less active and this creates a cycle of inactivity that it is difficult to fight.

Despite not finding statically differences in MVPA performed in PE classes between NOW and OW (37% vs 36%), a study conducted by Stuart J. Fairclough and Gareth Stratton (2006) has reported that in comparison with NOW adolescents, OW might not be provided with optimal psychological experiences during PE classes because their presented values for enjoyment and perceived competence lowers than the NOW (Stuart J. Fairclough & Gareth Stratton, 2006).

So it is important to create PE programs more committed to health benefits, seeking to contribute more to high MVPA levels, because OW is an unfortunate reality and the sooner we join efforts to fight it the more young people we can help to understand the importance that PA can have on their life and their well-being. It is also important to increase teachers' consciousness about the association between time spent in lesson contexts, promotion of PA, and student

engagement in MVPA, which is essential for fitness development (Smith et al., 2015).

*Compliance with the recommendations of 50% of the class time in MVPA and contribution of PE for the compliance of daily MVPA*

(Stratton, 1996) stated that schools do not provide, in number and duration, PE needed to meet PA recommendations, such as 50% of class time in MVPA (United States Department of Health and Human Services, 2000). Our results suggested that only 20% of participants meet the recommendations for the MVPA in 45PE and 15% in 90PE ($p<0.05$) and the mean of MVPA in the 45 and 90 minutes PE classes of participants that meet the recommendations is lightly above the recommended value (62.3% and 60.7%, respectively; $p<0.05$). However, the mean of MVPA of participants that do not meet the recommendations is markedly below the value recommended for the MVPA in the PE classes (24.7% in 45PE and 25% in 90PE; $p<0.05$).

Recently, in Portugal, we witnessed changes in educational policies with the curriculum undergoing important adjustments. In a country with the obesity prevalence rate increasingly higher, the PE curricular unit saw its frequency and duration being reduced in favor of other subjects. Actually, during elementary school, students have 135 minutes of PE per week, usually distributed in two PE classes, one session lasting 45 minutes and other lasting 90 minutes. Concerning secondary school students, they have 180 minutes of PE per week, dispersed in two 90-minutes PE classes. However, regarding this last one the PE lessons are no longer considered in the final average of the students. This devaluation of the curricular unit may be related to the minor relevance that the students give it, as well as their lower commitment and participation in class.

Comparing the data collected with the recommendation that children and adolescents should have at least 60 minutes of daily MVPA, we conclude that 45 minutes PE lessons contribute 16.8% for MVPA in PED45 and 90 minutes lessons contribute 34.7% to the MVPA in PED90, corresponding to 9 min and 19 min of MVPA, respectively. These results are similar to results found in other

studies that show percentages of 29% (S. J. Fairclough & G. Stratton, 2005), 20.5% (Kremer et al., 2012) and 42% (Ferreira et al., 2014) of PE classes' contribution to the 60 minutes of MVPA. As we can see, the results are still far below expectations. Maybe the strategies and goals for PE are outlined incorrectly or it is possible that the PA implemented outside of PE class represents a leading role in achieving the recommended time of 60 minutes a day of MVPA. Only data collected in the various studies conducted may contribute to the answer.

Analyzing the compliance with the international recommendations for daily MVPA taking account the existence or not of PE classes, our data suggest that on PED45 and PED90 higher number of youngsters complies with the 60 minutes of daily MVPA recommended (47.8% and 50.2%, respectively) and in NPED and WD the compliance is much lower (27.7% and 12.7%, respectively).

Having PE classes affect 3.18 and 2.90 times higher odds to comply with international MVPA daily recommendations, on PED45 and PED90, respectively. Additionally, boys are 3.69 times more probable to comply with the 60 minutes of daily MVPA than girls and older participants are 1.07 more likely to accomplish the recommendations than their younger counterparts. No differences were found for BMI.

These results are corroborated for the recent data found in the national food and physical activity survey 2015-2016 conducted in Portuguese population, which revealed that in Portugal and in the age group analyzed in our study, boys tend to be more active than girls and adolescents tend to be more active than their younger counterparts (IAN-AF, 2017).

*Contribution of PE for daily PA improvement*

Our results suggested that PE contributed considerably to overall daily PA. On PED45 participants performed 26 min more of TPA than on NPED and on PED90 they accumulated 30 min more, with PED45 contributing 10 min for daily MVPA and PED90 19 min. Furthermore, PE effectively increases daily MVPA levels, with youngsters engaged significantly more time in MVPA in PED than

during all others days of the week ($P < 0.05$). On average, this represents an improved MVPA participation of 16.9% in PED45 and 32.2% in PED90. So, this study supports the strong evidence that PA should be promoted in schools. Increasing daily MVPA from 49 min on NPED to 69 min on PED90 and 68 on PED45 could have a crucial contribution to achieve the recommendations and, thus, to reduce the metabolic disease risk. Other studies, that focused their attention on the relevance that PE classes have on children and adolescents' physical activity daily levels, have found similar results to ours. T. A. Brusseau et al. (2011), found that children and youth were more active during school days than on WD and on PED comparing with NPED. More recently, Gråstén et al. (2015) found that the two PE45 classes that students have on their week provide 26.2% and 33.6% of weekly MVPA of girls and boys, respectively. This concerning findings highlight the relevance of PE for the compliance of MVPA recommendations for young people and, consequently, to their health.

From a Public Health perspective, PE has a crucial contribution for TPA and for daily MVPA (Meyer et al., 2013) and in a PA intervention study, Kriemler et al. (2010) showed that increased MVPA daily participation improved fitness and reduced cardiovascular risk. Therefore, the expansion of PE across more school days may also serve to increase children's PA during the school week (T. A. Brusseau et al., 2011). Our results support the Expert Group on Health-enhancing physical activity (2015), that on their recommendations encourage PE in schools, including motor skills in early childhood, and to create valuable interactions with the sport sector, local authorities and the private sector, suggested that the minimum PE taught time recommended during compulsory education period should be increased to at least 5 lessons per week, approximately 5 hours.

Our findings have important policy implications for the organization of PE classes, emphasizing the need to create strategies to maximize MVPA participation, whether it is in PE classes, where teachers must be aware of the importance of promoting PA, providing students opportunities to improve their skills and contributing to ensure physically activeness, or providing non-competitive extracurricular programs which also have potential to increase MVPA

accumulated during the school day. The perceived difference between recommended PA levels and the limited curriculum time for PE should be considered because perhaps this is compromising the PA opportunities for youths.

# CHAPTER V – CONCLUSIONS, STUDY LIMITATIONS AND FUTURE PERSPECTIVES

The current dissertation adds to an increasingly active field of research in the analysis of the patterns of PA levels of Portuguese young in PE classes with different duration and their compliance with international recommendations for PA. Furthermore, emphasizes the contribution of PE classes to daily PA, comparing PA performed on PED, NPED and WD and taking account gender and weight status.

Considering the overall findings that emerged from the original studies we highlight the following conclusions:

- There were no differences in the PA levels performed in PE classes with different duration, excepting SB that it is higher on 90PE.
- Longer lessons do not necessarily produce more MVPA.

- The proportion of MVPA in 45 and 90 minutes PE classes is lower than the 50% recommended by guidelines.
- Only 20% of students comply with the recommendations in the 45PE and 15% in the 90PE. Participants who meet the recommendations do it just above the reference value and those that do not meet the recommendations only reach half the recommended amount.

- Boys spent significantly more time in MVPA than girls, and are 3.69 times more probable to comply with the 60 minutes of daily MVPA than girls. In contrast, girls spent more time in SB and LPA than boys.

- NOW spent significantly more time engaged in MVPA than OW. In contrast, OW spends more time in LPA in 90PE classes than NOW. OW were approximately three times more likely not to meet the > 50% MVPA in 45PE classes than their NOW counterparts.

- PE increased daily TPA and MVPA levels in young and played a considerable role in providing structured PA at these ages.
- Youngsters engaged significantly more time in MVPA in PED45 and

PED90 than during NPED or WD.

- On average, PE contributes with an improved MVPA participation of 16.9% in PED45 and 32.2% in PED90.
- Having PE classes affect 3.18 and 2.90 times higher odds to comply with international MVPA daily recommendations, on PED45 and PED90, respectively.

Some limitations of the study should be recognized. The study included youngsters from one metropolitan area only, which makes it difficult to generalize these findings. Additionally, it is not possible to infer causal relationships with cross-sectional design.

The large standard deviation found in our study suggests wide individual variations in MVPA and the importance of considering participants' intra-individual variability. Such variation in activity levels reflects the influence of contextual and pedagogical factors (such as: lesson objectives, content, environment, teaching styles ...) (Bevans et al., 2010; McKenzie et al., 2000).

This variability is particularly important bearing in mind that generally low levels of MVPA are being committed in PE classes and so it is important to understand how we can help students to be more active in PE classes and, consequently, throughout their day.

Nevertheless, this study focuses on the assessment of TPA and MVPA levels using an objective measure with a high compliance rate during school hours. The content of the PE lesson might considerably influence the extent of MVPA in PE, while none of the teachers knew about the specific assessment of the PE lessons we cannot completely rule out a bias towards more active PE lessons while the accelerometer was worn. To minimize this bias we adjusted our data to the content of the class.

These findings have important policy implications for the organization of PE classes, emphasizing that it is fundamental that health stays at the center of the planning, because such a curriculum engaged in contributing for the increase of the MVPA levels, collaborating for a controlled weight status, could help PE to

achieve their purposes, contributing to young people to be more active and healthier. Furthermore, accentuate the growing need to create strategies to maximize MVPA participation, whether it is in PE classes, where teachers must be aware of the importance of promoting PA, providing students with opportunities to improve their skills and contributing to ensure physically activeness, or providing non-competitive extracurricular programs which also have potential to increase MVPA accumulated during the school day. The perceived difference between recommended PA levels and the limited curriculum time for PE should be considered because perhaps this is compromising the PA opportunities for youths.

There is evidence that environmental factors, such as class size, location and class contexts influence the activity of young people and that there are clear policy implications for the PE class organization, which emphasize the need to create strategies to maximize MVPA participation (Skala et al., 2012).

Little is known whether PE promotes activities with intensity, duration and frequency sufficient to bring health benefits to students. The few studies found indicate that PE classes have short periods of sufficient intensity to cause physiological adaptations in students (Hino et al., 2007). The low proportion of time spent in class in physical efforts with sufficient intensity to promote physiological adaptations, as well as short duration of these stimulus is an important finding, but not sufficient.

Knowledge about the classes and teaching programs of school PE is still limited. New studies seeking to identify factors that influence the development of classes, as well as the determinants of physical activity practice of students in PE classes, should be performed.

# CHAPTER VI – REFERENCES

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